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Wire-Winding Big Guns for Uncle Sam

by

Chester L. Lucas *

THE strengthening of artillery by wire-winding is a subject that has received the attention of ordnance experts for years. There are many different opinions as to the merits of wire-wound guns, and they have been freely expressed by authorities in this country and abroad; therefore, it will not be attempted in this article to discuss wire-wound guns from the engineering standpoint, but rather to describe the details of the operation of applying the layers of wire to the gun as done in the United States Arsenal at Watervliet, N. Y.

The antiquity of the principle of reinforcing guns with wire is evidenced by an early cannon now in the museum at the Woolwich Arsenal in England, that was said to have been used by Gustavus Adolphus early in the seventeenth century. This cannon is about six feet in length, with a copper barrel, and is reinforced by being wound with hempen cord and then covered with leather. The practical application of this principle to modern warfare, however, commenced about 1850, with the efforts of Longridge in England and his contemporary Woodbridge in America. Since that time, the wire-wound gun has been used to a growing extent in Great Britain and Europe, but it is only during the past eight years that wire-wound guns have received official recognition in the United States. At the present time the wire-wound gun is used for coast defense only.

The Principle of the Wire-wound Gun

Before taking up the operation of wire-winding, a few words on the principle involved may not be amiss. Many years ago it became apparent to ordnance experts that a gun built up of successive tubes shrunk in place was far superior to a gun made from a solid billet. Under the gas pressure of firing, it was found that the metal nearest the bore of a solid gun was stretched beyond its elastic limit, while the outside metal was unaffected, receiving none of the strain. Therefore, no matter how thick the walls of the guns were made, the inner metal around the bore was the only part that received the gas pressure, and as soon as this metal became fatigued the gun was unfit for use. By building the guns of tubes, successively shrunk one over the other, it was found possible to close in the metal of the inner tube by shrink-pressure of the outer tubes so that when the gun was fired the metal of the inner tube had to be first expanded back to its natural condition and then stretched beyond its elastic limit before being fatigued. As the succeeding layers of these tubes were shrunk in position, this stretching of the inner tube was resisted by the pressure of each of the outside bands, and consequently the life of the gun was greatly lengthened; in addition, it was possible to build a much lighter gun of the same relative strength as the solid gun. From the above it will be seen that the winding of guns with wire that is under tension brings about the same condition as is obtained by shrinking on tubes successively, and it is claimed that the use of high tensile strength wire gives the gun strength attainable in no other way.

There are two principles employed in applying wire to guns, one of which consists in winding successive layers of wire at the same tension. The second system consists in winding the wire at a varying tension, decreasing with each successive layer. The first system is, of course, applied with the minimum amount of trouble, but it is claimed that the second principle has the advantage of distributing the firing strain in as nearly uniform a manner as possible.

Fig. 2 shows a sectional view of the Crozier type of wire-wound gun, reproduced from "Ordnance and Gunnery," by Capt. L. L. Bruff. This view is reproduced to illustrate the manner in which the layers of wire are distributed over the length of the gun. In each series of reinforcements, about ten layers of wire are applied. At the breech end of the gun, the reinforcement is heaviest. At the muzzle end the layers are fewer in number, but the wire is put on at a higher tension in order to give the necessary strength with the smallest amount of wire. Covering tubes are shrunk in place over the wire and each of these tubes is "stepped" so

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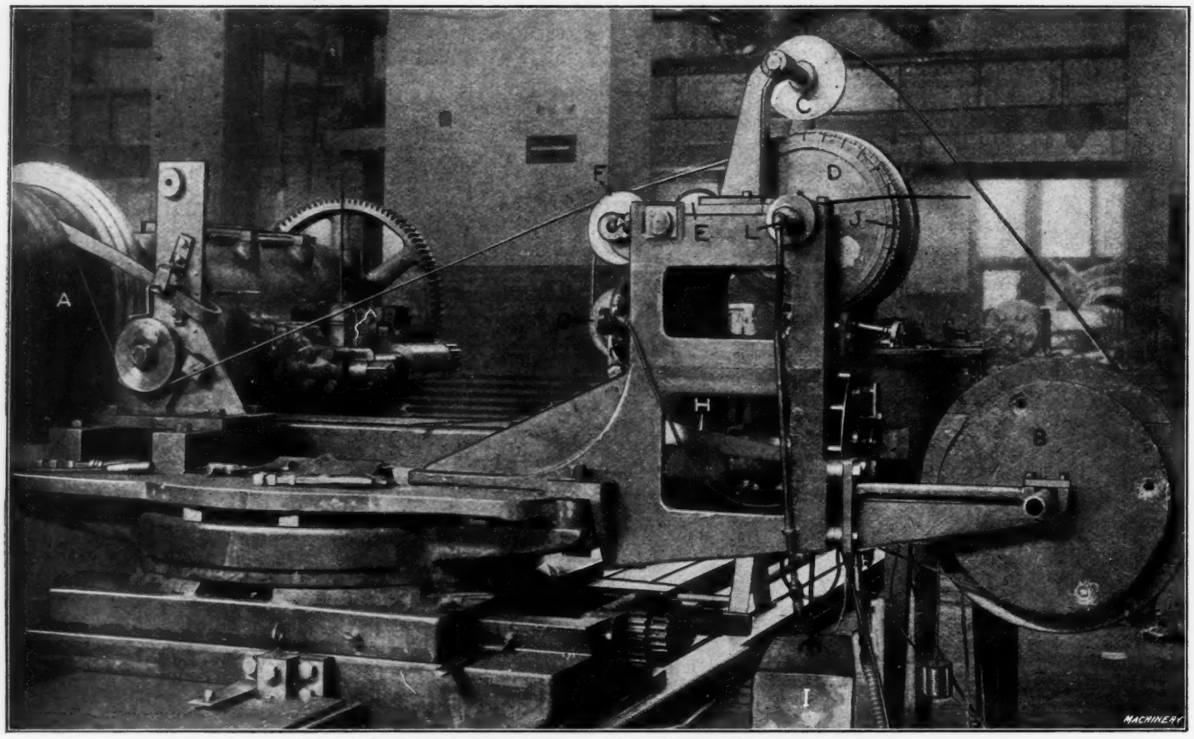

Fig. 1. Important Parts of Machine used for winding Wire on a 14-inch Gun

that it has a bearing on one of the adjacent tubes as well as on the layers of wire.

The wire used for this work in the United States is square in section, being one-eighth inch diameter with slightly rounded corners. The English and Continental practice employs for the most part wire of rectangular section. The material is cold-drawn steel, having a tensile strength of 180,000 pounds per square inch and an elastic limit of 140,000 pounds per square inch. Its quality is an all-important factor, and is maintained by rigid physical and metallurgical tests.

The Wire-winding Apparatus

Fig. 1 illustrates the operation of winding wire on a 14-inch gun. The work is done in a large gun lathe, and the gun itself is rotated, drawing the wire from the wire-reel as it is wound on the gun. Between the gun shown in Fig. 1 at *A* and the reel *B* is the tensioning mechanism. A similar tensioning mechanism is shown in Fig. 3, although the details of the latter are slightly different from those in Fig. 1. Both views, however, illustrate the principle. The wire, as it leaves the reel, passes over an idler *C* and thence between the two friction disks which are indicated at *D*. A guide wheel *E* is in contact with the edge of the friction disk, and insures that the wire enters properly.

When the wire passes between the halves of the friction disk, it just fits into a square recess, half of which is cut in each disk. A very powerful spiral spring presses the halves of the disk constantly on the sides of the wire, and it is one of the functions of guide wheel *E* to force the wire into the groove cut in the friction disk. The wire runs around the friction disks, being in contact for nearly three-fourths of the circumference, and then passes over the fixed pulley *F*. From there it runs down over the floating pulley *G*, forming a loop, and back again over another groove in pulley *F*. The arrangement of pulleys *F* and *G* is much the same as in the familiar block and tackle. Pulley *G* that floats in the loop of wire has suspended from its center a lever *H* that is pivoted on the extreme left-hand end, and on the extreme right-hand end of the long arm is hung the heavy weight *I*, shown only in Fig. 1. The weight on this lever may be varied, of course, to change the tension on the loop of wire, but in the illustration Fig. 1 this weight is 240 pounds and the leverage is so compounded that there is a pull on the wire amounting to 625 pounds. From these figures it may be seen that the wire, as it is wound on the gun, is under a tension of 40,000 pounds.

On the shaft with the friction disk is a brake drum that, in connection with two brake-bands, one of which is shown at *J*, impedes the rotation of the shaft. The object of having two brake-bands is to regulate the "drag" that is being applied to the wire. The wider of these bands is kept at a fixed tension, and the narrower is adjusted when increased or decreased drag on the wire is desired. The action of the brake and bands generates considerable heat, and to dissipate this, a stream of water passes through the center of the brake drum. The pipe for this purpose may be seen in the illustration, Fig. 3, entering the center of the axle at *L*. The drag of the friction upon the wire, on the one hand, and the pull of the wire as it is drawn onto the gun, on the other hand, support the wire while the tension is being secured. The compounded weight *I* that pulls upon the loop of wire around pulleys *F* and *G* gives this tension.

This lathe is geared so that the carriage holding the tensioning mechanism, wire and reel travels at the rate of one-eighth inch to each revolution of the spindle. As the wire is exactly one-eighth inch in diameter this, of course, is the proper lead. In order to make sure that the wire is wound closely, a spring finger bears against the strand of wire just before it is laid in place upon the gun. This insures that it is crowded over against the convolution previously applied. This may be seen on a large scale in Fig. 4. The wire is wound on the gun at the rate of 120 to 240 feet per minute.

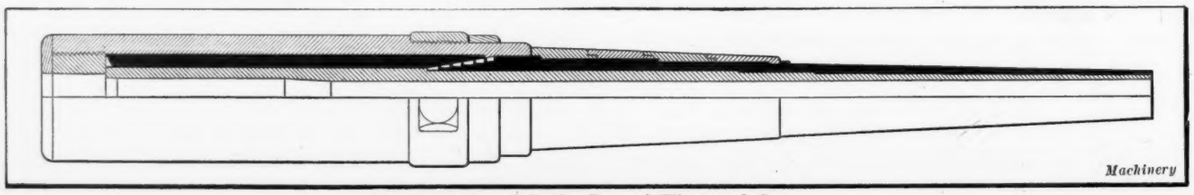

Fig. 2. Section of Crozier Type of Wire-wound Gun

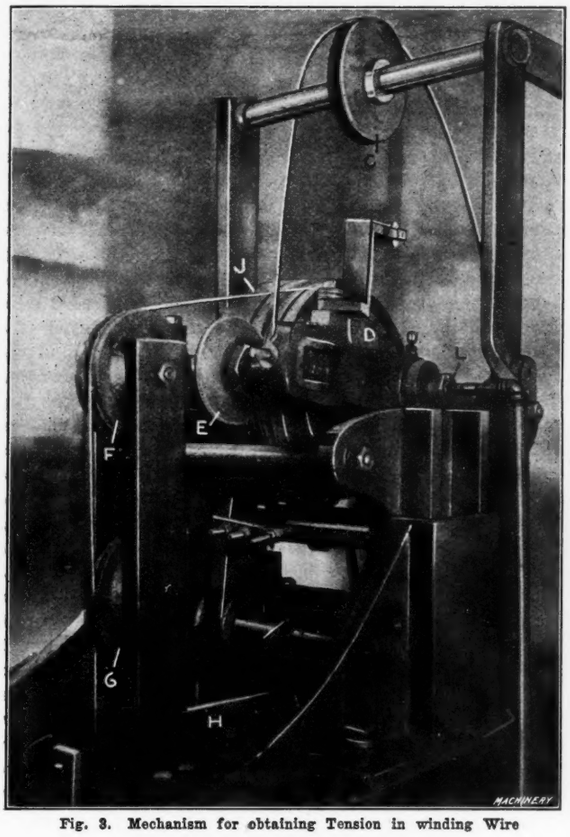

Fig. 3. Mechanism for obtaining Tension in winding Wire

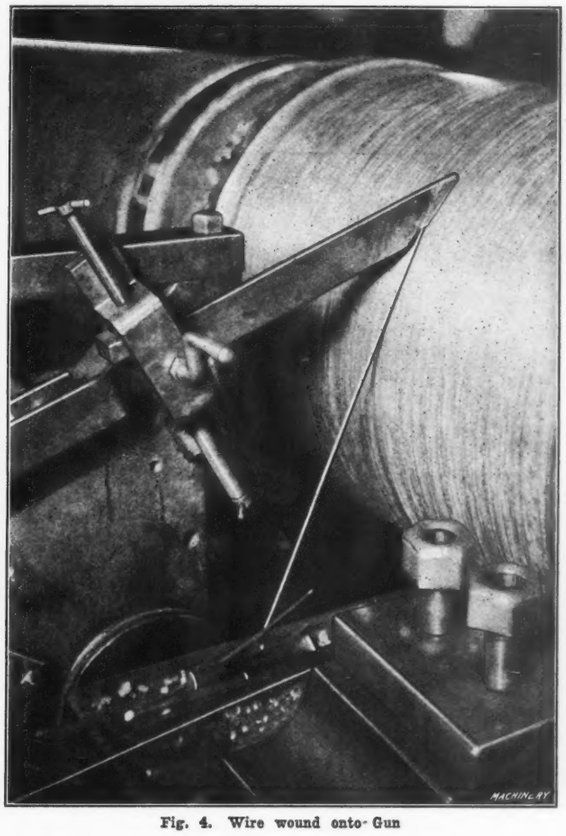

Fig. 4. Wire wound onto Gun

"Filling In" at the End of the Layers

At the end of each layer of wire it is obvious that there will be a space that the wire cannot fill on account of the fact that the turns are helical. This space is one-eighth inch wide at the beginning and tapers down to nothing at the end of the revolution, but even this slight space must be filled to complete the layer and form a good foundation for the next layer of wire. A strip of wire long enough to go around the gun is tapered for its entire length from one-eighth inch at one end to nothing at the other end. This is also tapered for about an inch at the thick end to fit in under the strand of wire as it passes up to the next layer. These points are clearly shown in Fig. 5. This length of tapered wire is carefully driven into place and the new layer started on its course. At the beginning of this new layer it is also necessary to insert another filler wire to close up the space left. Thus two filler wires are required for each layer of wire wound. As these filler wires are several feet long and only one-eighth inch square at the heavy end, it is rather difficult to hold them for planing the taper from end to end. The type of planing fixture used supports the wire on three sides, being clamped at six-inch intervals. Only the top is left open and but one wire is planed at a time.

When joining the end of one reel of wire to a new reel, the connection is made by electrically soldering with hard solder. The two ends of the wire are scarfed and clamped in the copper faced terminals of the electric heating fixture. Between the scarfed ends of the wire, a piece of sheet silver solder is placed and the joint well fluxed with a borax paste. The current is then turned on and ten seconds heats the ends, flows the solder, and completes the joining, and there is none of the "fuss" usually experienced when the blow-pipe is used.

On starting the strand of wire, the end is driven into a hole or recess in the gun body, and the end of the strand of wire on the last layer is also secured by being driven into a chiseled groove cut into the solid metal. The method of securing the end of the strand is illustrated in Fig. 6, and the groove is made small and deep enough so the wire can be driven down into it and the edges of the groove peened over onto the top of the wire, thus bolting it effectually.

After all the wire of the gun has been wound in place, a very light lathe cut is taken over the top layer, leaving the outside perfectly smooth so as to form a good surface upon which the next steel jacket may be shrunk. As the wire is cold-drawn to within limits of 0.001 inch there is very little unevenness, especially in view of the fact that it is under such high tension while being wound. The gun is now ready for the shrinkage on of the rings or covering tubes. The tubes are bored out to the external diameter of the wire, minus the allowance for shrinkage. Then, with the gun in a vertical position, breech down, and a stream of water within the bore to keep it cold, the shrink rings or tubes are heated and dropped into place. It may be well to draw attention to the fact that the shrinking on of these covering tubes is a very important operation and is done with great care. After the shrinkage allowances are calculated, the tubes must be heated very evenly before they are applied. The operation of heating is extremely important, but the careful manner in which this work is done at the United States Arsenal at Watervliet adds the finishing touches of strength, safety and reliability to the gun.

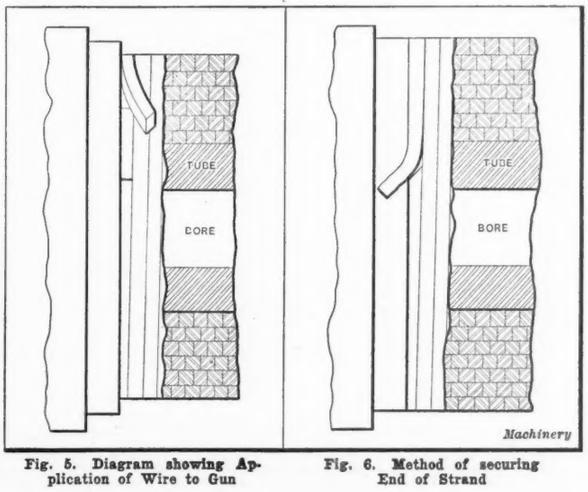

Fig. 5. Diagram showing Application of Wire to Gun

Fig. 6. Method of securing End of Strand

DIES FOR DRAWING FLANGED SHELLS*

METHOD OF FORMING FLANGED SHELL BY FORCING SURPLUS METAL FROM SHELL BODY UP INTO FLANGE

BY E. P. DAVIS†

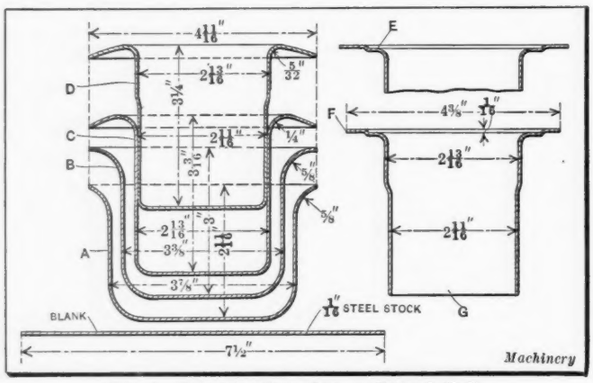

Fig. 1. Successive Operations on Flanged Shell

THE flanged shells produced in the dies to be described in this article are for automobile electric horns and are a "Made in Bridgeport" product. The successive operations from the flat blank to the finished shell are shown in Fig. 1, the order of the reference letters indicating the order of the operations. The dies used are shown in Fig. 2 and are marked with corresponding reference letters, die *A* being used for the first drawing operation *A* (Fig. 1), die *B* for the second operation, and so on. The finished shell has a flange 4⅜ inches in diameter with a recessed shoulder 1/16 inch deep. The body of the shell has two diameters of 2 13/16 and 2 11/16 inches, respectively, and it is 3 1/4 inches long. The shell is made of "three-quarter hard," cold-rolled steel, 1/16 inch thick. The blank diameter was computed by the ordinary method of finding the area of the finished shell in square inches, and then making the blank diameter to correspond to this area. In this case the area is about 43 square inches, which is approximately equal to the area of a circle 7½ inches in diameter. Several circular blanks of this size were cut to be used in making the trial drawing operations.

There are two methods of drawing a flanged shell which require more than one operation. The method that is commonly employed is to first draw the blank into a flanged cup and then reduce the size of both the cup and flange by means of successive redrawing operations until the required dimensions are obtained. When this method is employed, the width of the flange remains approximately the same, but the flange is reduced in diameter for each successive redrawing operation, the metal being drawn into the body of the cup or shell. The other method differs from the one just referred to in that the outside diameter of the flange remains about the same for all the drawing operations but the radius is diminished and the width increased for each successive operation, some of the surplus metal obtained when reducing the body diameter being forced up into the flange. Thus, as the diameter of the shell body is decreased, some of the metal flows up into the flange which is thereby increased in width; of course, the stroke of the press must be so adjusted that the drawing punch will not descend far enough to pull in the flange, thus reducing the original diameter. This second method makes it possible to secure a greater reduction in diameter of the shell body in one drawing operation, and a greater length of cup in the first operation, which reduces the strain on the metal in succeeding operations; therefore the second method ordinarily is preferable when the flange diameter is large in proportion to the diameter of the shell.

When the flange and shell body are both reduced, the flange width remaining about the same, the metal is subjected to a greater strain and more stretching, and, consequently, is made harder and more brittle, thereby necessitating several annealing operations. This additional strain upon the metal is due to the fact that a flat flange is reduced in size for each operation and must be drawn into the body of the shell. On the other hand, when the flange is gradually enlarged by pushing the metal up into it from the shell body, the stress

* For additional information on drawing shells, see "Drawing a Flanged and Tapered Cylindrical Shell," March, 1912, and articles there referred to.

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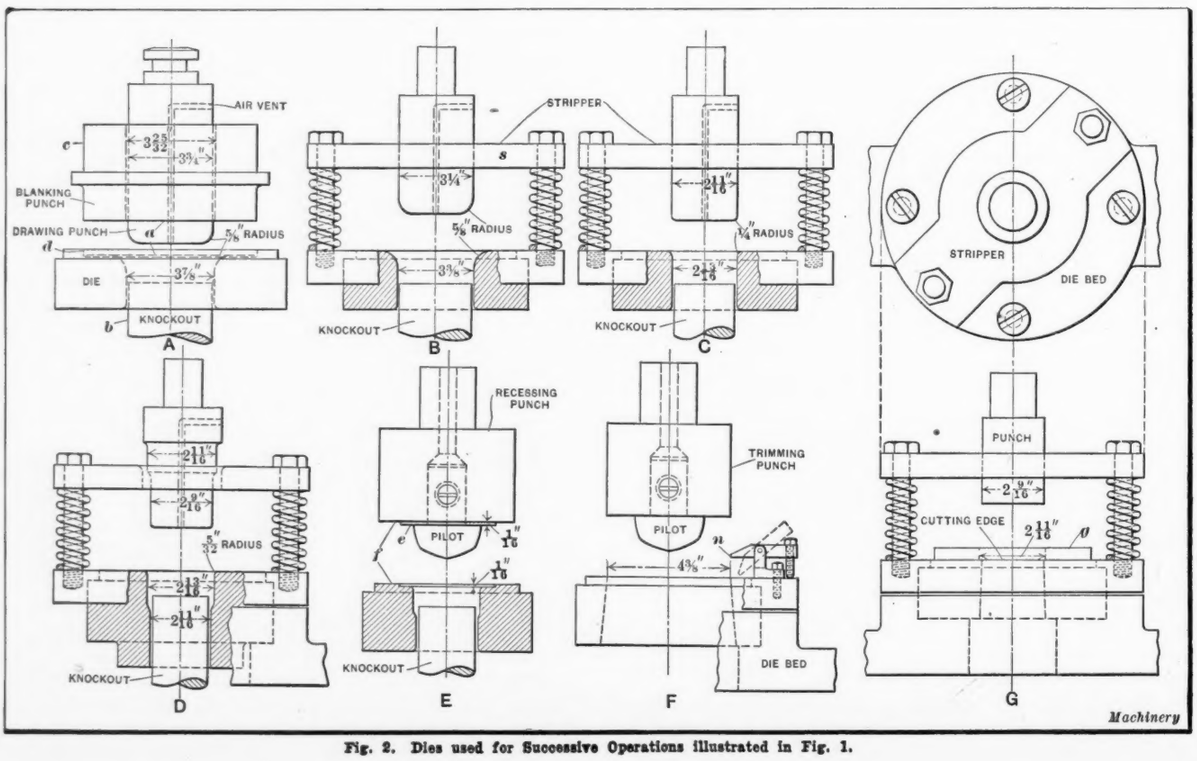

Fig. 2. Dies used for Successive Operations illustrated in Fig. 1.

on the metal is less. Even though the same number of press operations may be required with one method as with the other, the second one referred to is often preferable, not only because it reduces the number of annealings necessary but also because it enables cheaper dies to be used and gives a more uniform thickness of metal in the finished part.

When designing dies for forming a flange by pushing the metal up into the flange, it is advisable to have as large a radius on the drawing edge of the first die as possible, the radius on dies for succeeding operations being reduced when necessary, thus forcing the surplus metal into the flange. When designing dies for the shell illustrated in Fig. 1, the method of establishing the diameters of the drawing dies described in the following was employed. First the diameter of the blank was determined from the area of the finished shell and, as previously mentioned, was found to be 7½ inches, the shell area being about 43 square inches. Now assuming that a flange was not required on this shell, the blank diameter would be 6 9/16 inches. Thus, as the total area of the shell is 43 square inches and the flange area approximately 9 square inches, the area of the shell without a flange equals $43 - 9 = 34$ square inches, which equals the area of a circle 6 9/16 inches in diameter. Having these two

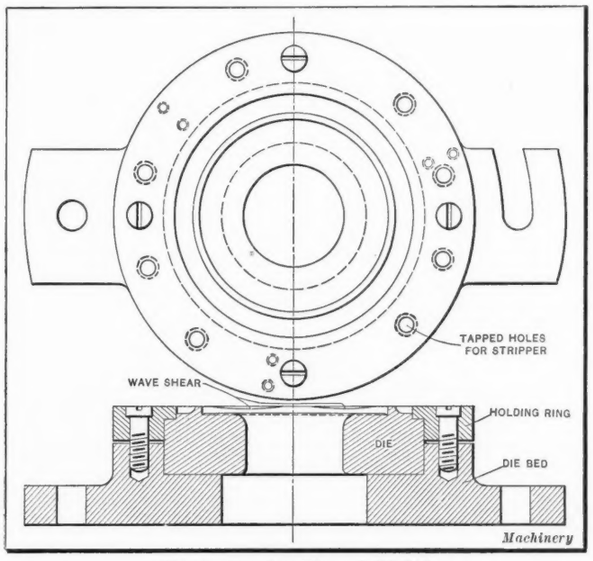

Fig. 3. Drawing Die and Die-bed

blank diameters, the respective diameters of plain flangeless cups into which they could be drawn in one operation are determined by dividing each blank diameter by the constant 1.8. (Incidentally this is a good general rule for determining the diameter of a first-operation or "cupping" die, or, in other words, the diameter to which a flat blank can be drawn in one operation.) The arithmetical mean between these two cup diameters is then determined and the diameter of the first drawing die made equal to this mean diameter. Thus, $\frac{6\ 9/16}{1.8} = 3.64$ inches, which represents the diameter to which the blank for a flangeless cup could be drawn in one operation. Similarly, the diameter into which the larger blank could be drawn equals $\frac{7\frac{1}{2}}{1.8} = 4.166$ inches. The mean diameter equals $\frac{4.166 + 3.64}{2} = 3\frac{7}{8}$ inches, approximately. Now, one operation could be eliminated in the drawing of this shell by making the first-operation or cupping die 3½ inches in diameter and the second die equal to the large size of the finished shell or 2 13/16 inches in diameter. If this were done, however, the metal would be strained and made hard and thereby require two annealings; consequently, the mean diameter of 3⅞ inches was selected for the first-operation die, as it was within the limits of three drawing operations.

A uniform thickness of metal was required in this shell which necessitated great care in making the drawing corners of the punch and die as round and smooth as possible, in order to insure an even distribution of the metal. The outside surfaces of all dies were turned concentric with the center holes and were made interchangeable in several different die-beds of the type illustrated in Fig. 3. The holding ring which clamps the die to the bed has several tapped holes, as shown by the plan view, for fastening the stripper plates, which will be referred to later.

The die for the first operation, by means of which the flat blank is drawn into cup *A*, Fig. 1, is shown at *A*, Fig. 2. A double-action press is used. The blank, after being cut by the blanking punch, is held between surfaces *a* with sufficient pressure to prevent the blank from wrinkling while the drawing punch pushes it through the die to the proper depth, which, in this operation, is 2 11/16 inches, leaving the flange diameter 4 11/16 inches. It should be mentioned that the correctness of this flange diameter was determined by several trial drawing operations, which also showed that a shell of the required depth could be obtained. The knock-out rod *b*, the upper end of which is shown, is actuated by a cam on the crankshaft and serves to push the shell out of the die. The shank *c* of the blanking punch was turned straight and pressed tightly into the punch block of the press, where it was retained with a set-screw. As the illustration shows, the drawing punch is provided with an air vent to prevent the formation of a partial vacuum between the end of the punch and shell when the latter is being stripped. These air vents are also used on the drawing punches for succeeding operations, as the illustration shows.

The blanking punch of die *A* is bored 1/32 inch larger in diameter than the drawing punch to prevent any binding between the two. Each drawing punch is ⅛ inch smaller in diameter than the die to allow for the thickness of the stock. All of the punches were ground after hardening and were made slightly tapering, the lower or drawing end being 0.002 or 0.003 inch small to facilitate stripping the shell from the punch. The recess *d* which forms the cutting edge of the blanking die was not turned until the correct blank diameter was determined by trial drawing operations. After deciding on the exact blank diameter, the recess in the die was ground and the hardened blanking punch also ground to fit into it. The hole in the drawing die was not only ground but lapped, because a lapped hole has a longer life than one that is merely finished by grinding. This die, when in use, was held in the type of die-bed illustrated in Fig. 3. The shell was annealed after this first operation and did not require any further annealing.

A very safe rule for determining the diameter of a redrawing die and the amount that a shell can be reduced in diameter in a redrawing operation, when using steel varying from 1/32 to 3/32 inch in thickness, is as follows: The diameter of redrawing die = shell diameter $- \frac{\text{shell diameter}}{5}$; that is, the shell is reduced an amount equal to 20 per cent of the diameter. Applying this rule or formula to the cup shown at *A*, Fig. 1, we have $3\frac{7}{8}$ inches $- \frac{3\frac{7}{8}}{5} = 3.1$ inches, which according to the formula should be the diameter of the die for the second operation; as the diameter of the finished shell is 2 13/16 inches, and as it was not considered practicable to reduce the cup to this dimension, the second-operation die was made 3⅜ inches, thereby equalizing the work and producing a better shell.

The die for this first redrawing operation is shown at *B*, Fig. 2; it is equipped with a stripper *s*, the shape and position of which is clearly shown by the plan view of die *G*, the strippers of all the dies being of the same form. As will be seen, the stripper is set at an angle to clear the guides of the press ram. The cup is placed on top of the die under the stripper, the springs shown holding the stripper in its upper position. When redrawing the cup, the punch descends and enters it and then the ram press strikes the stripper, carrying it down while the punch is pushing the cup into the die. On the return or upward stroke of the press, the shell sticks to the punch until the stripper plate strikes the heads of the bolts shown; then the shell is stripped from

the punch as the ram continues to ascend to its upper position. The radius on the drawing corners of the punch and drawing die is 5/8 inch and corresponds to the radius on the punch and die shown at *A*. Die *B* produces the cup *B* (Fig. 1) and is used in a single-action press.

The third operation (second redrawing operation) is performed in the die shown at *C*, which is also used in a single-action press and is similar to die *B*, excepting, of course, that it is smaller in diameter. The diameter corresponds to the large size of the finished shell or 2 13/16 inches. According to the formula previously given, the diameter would equal $3\frac{3}{8} - \frac{3\frac{3}{8}}{5} = 2.7$. Therefore the reduction to a diameter of 2 13/16 inches is a little less than the safe maximum, which tends to produce a better shell. As the illustration shows, the radius on the corners of the punch and die is 1/4 inch. When the shell has been drawn in die *C*, the flange is curved down somewhat as illustrated at *C*, Fig. 1. The flange is curved in this way as the surplus metal from the body of the shell is forced up into it, but is flattened by a subsequent operation.

Shell *C* is next changed to the form indicated at *D* in the die *D*, Fig. 2. This operation simply reduces the lower part of the shell body 1/8 inch in diameter or to the finished size of 2 11/16 inches, and retains the 2 13/16-inch size previously drawn. The next operation is that of forming the recess *E* in the flange, die *E*, Fig. 2, being used for this purpose. The shell is placed in the die and on top of the knockout rod. When the punch descends, the pilot attached to it enters the shell and the knockout rod also descends at the same time. The shoulder *e* on the punch is 1/8 inch smaller in diameter than the recess in the die, and it forms a recess in the flange, while surfaces *f* flatten the remaining part of the flange. When the punch ascends, the knockout rod pushes the shell out of the die. The pilot has a shank which is a light driving fit in the punch and is held by a set-screw.

The punch and die for trimming the flange to the required diameter of 4 5/8 inches is shown at *F*. When the shell is dropped into the die, the flange strikes the ends of three gravity strippers *n* which tilt to allow the shell to pass, as indicated by the dotted lines, and then fall back to the horizontal position. These gravity strippers are adjusted so that the inner ends *n* just clear the punch. When the punch descends, the pilot locates the shell in a central position and then the flange is trimmed. The shell drops through the die, and as the punch ascends the scrap which was trimmed from the flange sticks to it until it is stripped off by the strippers *n*.

The punch and die for the final operation of blanking out the bottom of the shell are shown by the elevation and plan view at *G*. The shell is placed in the ring or "nest" *g* and under the stripper plate. The punch is made long so that the ram of the press will not strike the stripper when it descends, the stripper for this operation simply being held up against the heads of the retaining bolts.

* * *

NICKEL-PLATED ALUMINUM

There has been no method in the past by which aluminum could be nickel-plated, but a British patent has been issued recently by means of which this can now be accomplished. The method is known as the Canac process, in which the aluminum is first treated with a boiling potassium carbonate solution, then brushed with milk of lime, and then immersed for a few minutes in a 0.2 per cent solution of potassium cyanide, and in a solution of 15 grains of iron to each quart of hydrochloric acid, until it obtains a moiré appearance. The nickel is deposited in the usual way from a bath containing about 750 grains of nickel chloride and 300 grains of boric acid for each quart of solution. The addition of iron to the last preparing solution is essential. A minute deposit of iron is found on the aluminum, causing a cellular structure on the surface. The iron appears to form a network of microscopic galvanic couples, which produces a rough surface. This accounts, it is stated, for the strong adhesion of the deposit which cannot be detached without also tearing off aluminum particles.

CONVERTING AN ENGINE LATHE INTO A SEMI-AUTOMATIC MACHINE

Many ingenious arrangements have been applied to engine lathes for increasing their capacity and adaptability for certain special manufacturing operations. An interesting attachment of this class is used on an R. K. LeBlond 18-inch

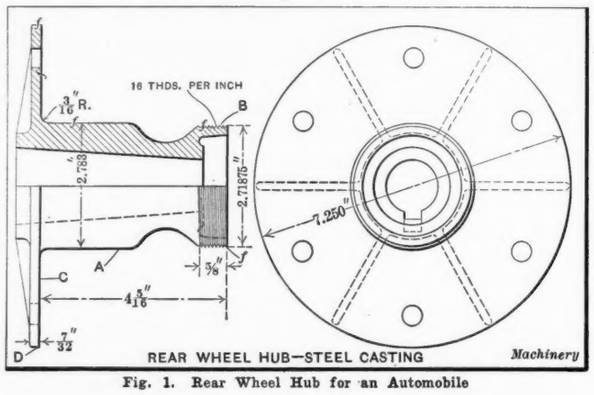

Fig. 1. Rear Wheel Hub for an Automobile

heavy-duty engine lathe in the plant of the Reo Motor Car Co., Lansing, Mich., for machining the rear wheel hubs shown in Fig. 1. The hub is made from a steel casting, and previous to the lathe operation the tapered hole, back and front faces, and counterbored recess, are machined in a New Britain semi-automatic chucking machine.

The next operations consist in turning the bodies *A* and *B*, facing the flange *C*, and turning the large external rim *D* in the Le Blond heavy-duty engine lathe shown in Fig. 2. Referring to this illustration, it will be noticed that a turret toolpost takes the place of the ordinary standard toolpost, and

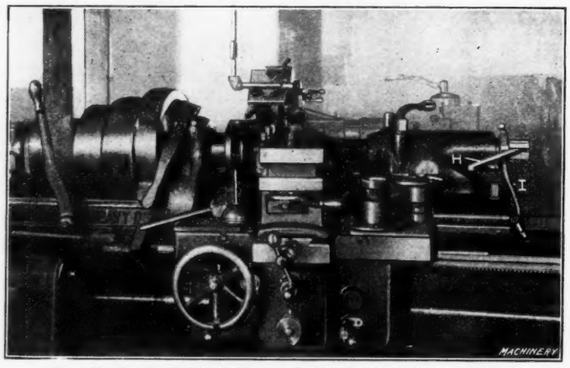

Fig. 2. R. K. LeBlond Engine Lathe fitted up for machining Rear Wheel Hubs

the regular tailstock spindle is removed and replaced by a special spindle in which a Geometric self-opening die *F*, Fig. 5, is held by means of a tail-spindle. A strap *G*, Fig. 3, fastened to the rear of the tailstock carriage, acts as a fulcrum point for the operating lever *H*, which fits in a slot in the special tailstock spindle. This lever is used to force the Geometric die forward and start it on the work, after which, of course, it leads along automatically. The special tailstock spindle is prevented from turning by dog *I*, one end of which rests on the bed of the lathe.

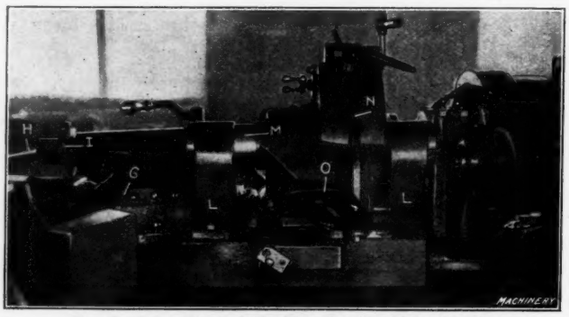

Fig. 3. Rear View of Machine showing Plate Cam for operating Facing Slide

For turning the surfaces *A*, *B* and *D*, three tools held in the toolpost *J* are used. The operation is clearly illustrated by the diagram shown in Fig. 4. At the same time that these three tools are working, two other tools, held in a special cam-operated slide at the rear, face the flange *C* and chamfer the corner *E*. The construction and operation of this special slide can be more clearly seen in Fig. 3. Fastened to the ways of the lathe are two brackets *L* held stationary by cap-screws. These brackets carry a trunnion *M*, which serves as a fulcrum member for the arm *N* carrying the facing slide. For the operation of this slide, a special irregular-shaped cam-

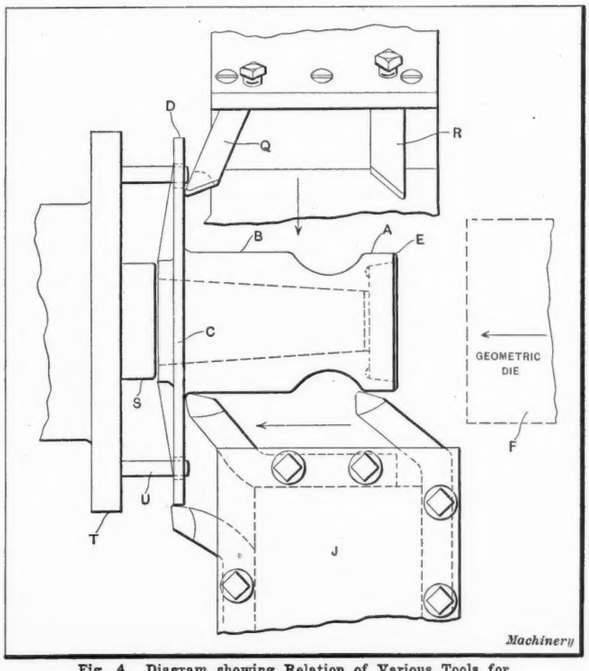

Fig. 4. Diagram showing Relation of Various Tools for machining a Rear Wheel Hub

plate *O* is used. This is fastened to the carriage of the lathe and consequently travels with it. A roll held to the arm carrying the additional cross-slide operates in the cam groove in this plate and transfers a movement to the arm, forcing the forward end downward and bringing the tools into operation on the work. This chamfering and facing operation takes place at the same time that the body and flange of the casting are being turned by the tools held in the toolpost on the regular cross-slide.

The additional cross-slide *P*, as shown in Fig. 5, fits in a dovetail groove in the top face of the arm *N* and is adjustably mounted in position. A hand crank, as shown, is used to move this slide along so that it can be brought into the proper relation to the work—that is, so that the turning tools held in it can be brought into the proper relation with the tools held on the front of the cross-slide. This adjustment is necessary in order that the facing tools will finish their work

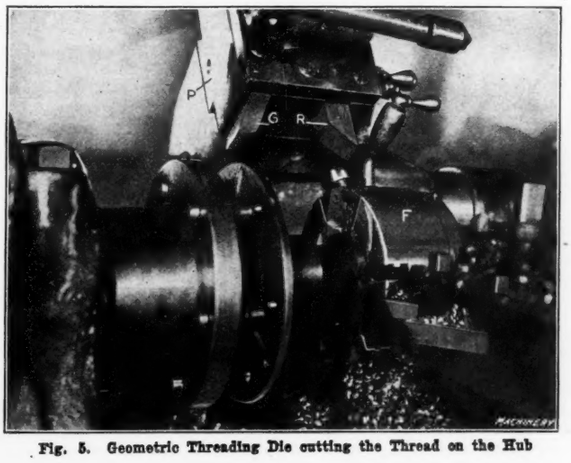

Fig. 5. Geometric Threading Die cutting the Thread on the Hub

at the same time that the front tools finish turning the body diameters. Tool *Q* is used to face the flange, whereas tool *R* is used to chamfer the edge of the work to enable the Geometric die to start easily.

Upon the completion of the turning and facing operations, these slides are backed out of the way, and the Geometric die is brought into operation. This is clearly shown in Fig. 5. The work, which has a tapered hole, is forced onto a special arbor *S* in the faceplate *T*, and pins *U* held in the faceplate locate in previously drilled holes in the flange of the work to act as driving members. The only attention that this fixture requires is to put on and remove the work, bring the cross-slides into position, throw in the feed, and start the die. The turning and facing is done automatically. There are five operations performed on this casting, and one hundred and sixty-seven pieces are turned out complete in nine hours—turned, faced, chamfered and threaded. D. T. H.

* * *

NON-PRODUCTIVE LABOR

In a paper presented before the American Society of Mechanical Engineers, December, 1914, H. L. Gantt referred to the absurdity of considering as non-productive all labor which was not directly employed at machines or in manufacturing operations. In many factories, the foreman is not supposed to permit the ratio of cost for non-productive labor to exceed a certain percentage of the cost of productive labor—a most harmful rule. The absurdity can best be made clear by an example, showing the fallacy of establishing such a ratio. A foreman had ten men on a job which he said could have been done by eight men, providing he could employ a boy to supply the men with the work. However, if he employed a boy for this purpose, the latter's wages would be called non-productive labor; the ratio between productive and non-productive labor in his department would be increased, and as a result he would be criticised; hence he did not make the change. As another example was mentioned the case of an energetic officer in the United States Navy who studied the loading of ammunition and greatly reduced the direct labor cost, but being unable to reduce the indirect or non-productive labor cost in the same proportion, the ratio between the non-productive and productive labor went up, and he was severely criticised, notwithstanding the fact that the total labor cost was decidedly reduced.

One of the arguments made by employers against scientific management is that it increases the non-productive labor cost. This may be true in many instances, although by no means in all, and if the management is what it claims to be—scientific—it will reduce the productive labor costs in a much greater ratio than it increases the non-productive costs, so that after all there is bound to be a substantial gain. Of course, there are many systems of management passing under the name scientific that lack the fundamental principles of the system that should properly be so called and in which a great deal of red tape is introduced, adding to the non-productive labor cost without producing any material saving; but the fact that many people are unable to grasp the inherent principles of scientific management does not make this system less valuable in reducing costs, where it is properly applied.

* * *

Scientific management suffers more from the fact that too great claims have been made for it than from anything else. It will reduce costs or, what is its equivalent, the time and effort necessary to do a certain amount of work, but it will not solve the labor problem; it will not, in the long run, tend to raise the wages of the workers or the profits of the manufacturer. A far more fundamental reform is necessary for that. When everybody employs scientific management, no one will have any advantage over anybody else, assuming that all other conditions remain as they are at present; a certain percentage of wages and profits then as now will tend to go to a non-producer—not a non-producer employed in the factory, but one who owns or controls natural resources and who can charge those who work by brain or hand for the use of these resources.

MACHINING IRREGULAR CONTOURS

SOME FIXTURES AND ATTACHMENTS FOR TURNING AND FORMING SHAPES NOT READILY PRODUCED BY REGULAR METHODS

BY ALBERT A. DOWD*

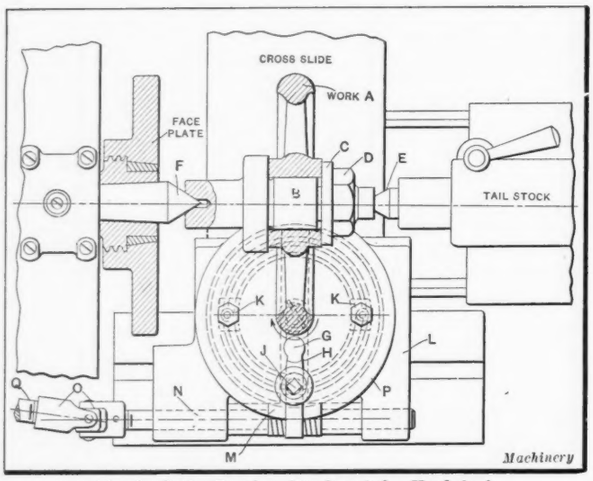

Fig. 1. Lathe Forming Attachment for Handwheel

THERE are numerous instances in general manufacturing when external or internal surfaces must be machined to a form or contour which cannot readily be developed by ordinary methods. If the required form is a plain taper or a perfect radius, it can usually be machined by some one of the methods described in MACHINERY, December, 1913, in the article "Taper Boring and Turning Attachments," or January, 1914, "Machining Convex and Concave Surfaces." When, however, the surfaces are irregular, having possibly both angular and curved portions adjacent, it is apparent that other means must be provided.

The character of the castings or forgings, and the material of which they are composed, together with their size and shape, have an influence on the design of the tools and devices which are to be used in the process of machining. The machines to which the devices are to be applied also affect the design to a considerable extent. For formed work of irregular shape which is not cylindrical, several methods may be used in the machining. The work may be done on the milling machine using special cutters of the required form, a profiling machine may be used, or a milling machine may be adapted, with a swivel or sliding fixture having a roll which follows a fixed form, thereby generating the required contour. For work of a cylindrical character, the engine lathe, horizontal or vertical turret lathe, or the vertical boring mill, are the machines most frequently used.

When the work is of small size and of such material that it can be formed to advantage, special forming tools of the required shape can be employed with excellent results, but when of large size or of some material which does not lend itself well to wide tool forming, it will be frequently found necessary to generate the contour by means of special devices or attachments.

There are a few general points in the design and construction of forming attachments for this class of work which are of interest, and these should be carefully considered both in the preliminary stages and during the progress of the design.

Points in Design

1. The number of pieces to be machined should be one of the first points considered, for if designed for a small number, the fixtures should be made up as cheaply as is consistent with the nature of the work to be done and the accuracy required. On the other hand, when designed for the machining of a large number of pieces, rapidity of action and upkeep of the fixture should receive more consideration than the first cost.

2. The accuracy required in the finished work is very important; if two cuts are needed to produce the piece to the desired limits, it is obvious that some provision must be made so that both roughing and finishing tools can be used. This may be done either by using a revolving or swinging tool-holder, or by making it in such a way that the tools can be accurately interchanged.

3. Take-up for wear is important. Moving surfaces which are subject to wear should be provided with means of adjustment, by which they may be brought into their proper positions when worn. Gibs, straps or other devices should always be incorporated in the design with this end in view. Parts subject to extreme wear which can not conveniently be made adjustable should be so designed that they can readily be replaced when necessary. Cam-plates should be so placed and located that their replacement will not cause inaccuracies, due to slightly varying locations.

4. Rigidity is a feature that must always receive consideration. In order to avoid any possibility of "chatter," the various parts of the attachment must be proportioned generously, with an ample amount of metal to withstand shocks. It is well to note in this connection that solid masses are better than ribbed parts (within certain limits), and less vibration will be apparent in a fixture or attachment having well distributed metal of generous section in its construction than in one of lighter section which is ribbed to give the desired stiffness. Excessive overhang in the tool-holder or carrier should be avoided as far as possible, and a bearing provided as nearly under the tool as can be arranged. In the method of holding the work which is to be machined, care also must be used so that no vibration will take place, due to excessive overhang or fragile construction.

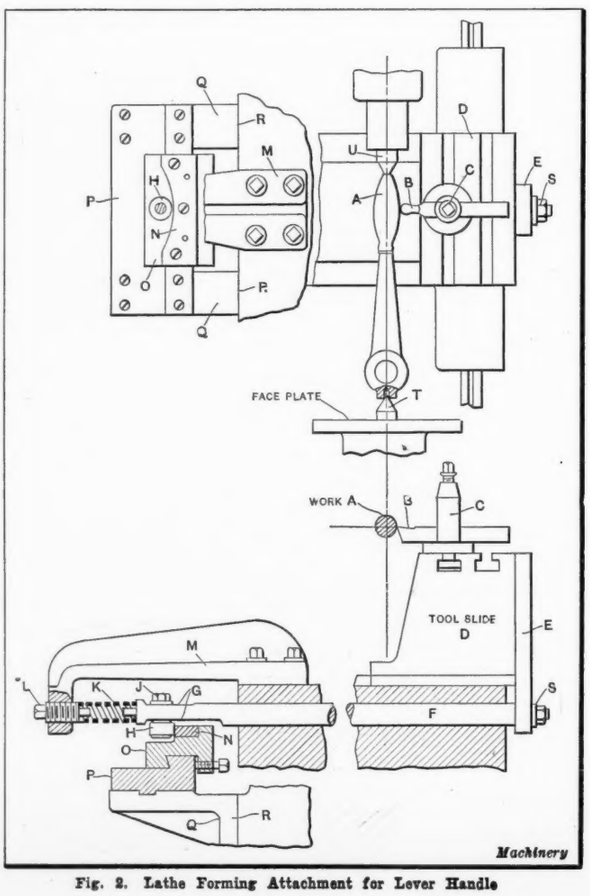

Fig. 2. Lathe Forming Attachment for Lever Handle

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5. The direction of thrust against the cam surface which controls the shape of the contour to be formed should be definitely controlled. Whenever possible, this arrangement should be such that the thrust of the tool will carry the roll or guide pin against the forming plate instead of in a contrary direction. If this is done the form of the work is positively assured, while if dependence is placed on a spring or weights to keep the guide pin in contact with the form, there is always a chance for errors due to hard spots in the casting which tend to throw the tool away from the work.

6. Convenience in handling and adjusting should be carefully considered during the progress of the design, looking into the matter from the operator's standpoint.

7. Interferences with other moving portions of the machine, such as turret, cross-slide, chucking device or special tools which may be in position for other work on either cross-slide or turret are of supreme importance on turret lathe work; it is sometimes possible by the exercise of forethought to make combinations of tools in such a way that several can be worked simultaneously.

Other points in design and construction will be noted in specific cases during the progress of this article.

Lathe Forming Attachment for a Handwheel

The work shown at *A* in Fig. 1 is a handwheel such as is used commonly in machine construction. The work has been previously chucked and faced and the periphery is to be formed in the operation shown, an old-style engine lathe being used for the machining. There were six different sizes of wheels to be formed, and the same attachment was used for the various pieces, although separate arbors were required. The piece is located on the cylindrical portion of the arbor *B*, this being centered in the usual manner at *F* and *E*, and driven by a dog (not shown) through the medium of the faceplate on the spindle end. A nut *D* and washer *C* are used to draw the hub of the work up against the shoulder on the arbor so that both clamping and positive longitudinal location are assured.

A special casting *L* is mounted on the front of the cut-off slide and carries the revolving plate *P*, on the under side of which a worm-wheel is fastened which meshes with the worm-gear *M* on the shaft *N*. This shaft is journaled in the overhanging portion of the casting *L*, and is provided with a universal joint *O* which allows flexibility of movement and is furnished with a sliding sleeve, and another universal joint at the other end where it is carried on a special bracket attached to the bed of the machine. It is given the necessary rotary motion by a spur gear which meshes with another on the end of the lead-screw shaft. These connections are not shown in the illustration.

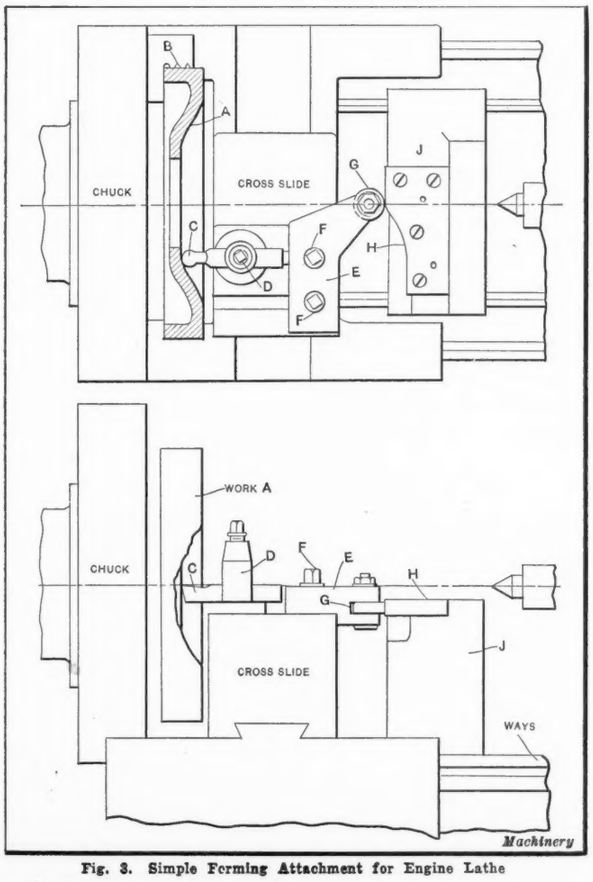

Fig. 3. Simple Forming Attachment for Engine Lathe

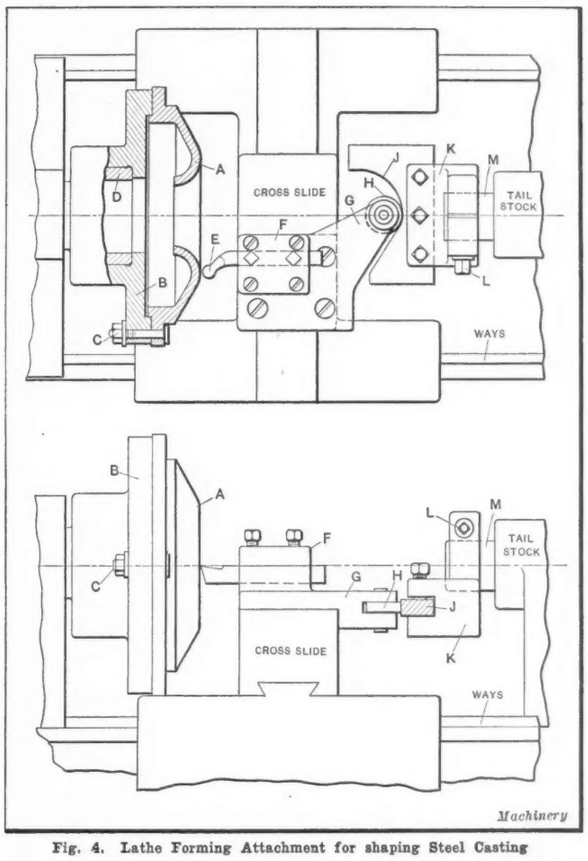

Fig. 4. Lathe Forming Attachment for shaping Steel Casting

The tool *G* is of the round-nose type and formed to a radius on the end. A tee-slot *H* is cut on the revolving plate and a regular lathe toolpost *J* carries the tool, being adjustable in the slot so that various radii may be generated. The cut-off slide may be readily adjusted for diameters, so that a number of sizes of wheels can be turned. After the work has been done the screws at *K* are loosened and the tool-carrying plate pulled around by hand to the original starting position. A tee-slot of circular shape is cut in the worm-wheel, and the two shoes draw it up against the under side of the plate when the screws are tightened. This was a somewhat crude arrangement and could have been improved by mounting the tool on an arm with a quick-acting binder, so that it could have been rapidly swung to any desired position and locked. This attachment was made over twenty years ago, however, and the value of time in machining was not as carefully considered at that time as it is at present. That the attachment was successful is indicated by the fact that it is still in use and performs its work in a satisfactory manner.

Lathe Forming Attachment for a Lever Handle

The work shown at *A* in Fig. 2 is an ordinary hand lever which has been chucked faced and centered in a previous operation, and which is to be formed to the contour required on the handle portion during this operation. An old-style lathe was selected for the purpose, which had had a taper turning attachment, a part of which was utilized for the work in hand. The work was located on the lathe centers at *T* and *U*, and was dogged and driven through the faceplate in the usual manner.

A new steel rod *F* was made to take the place of the old

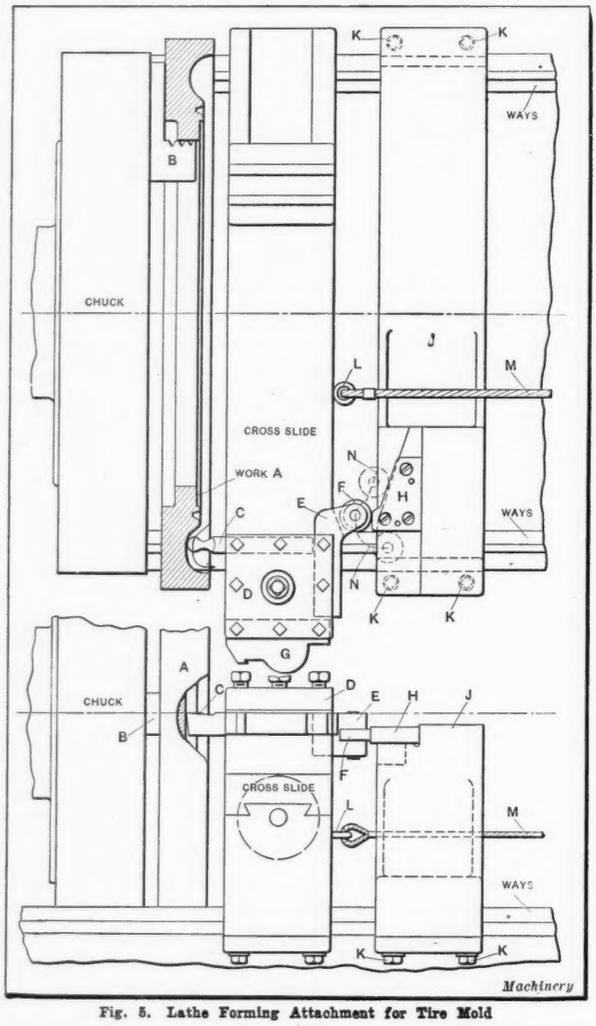

Fig. 5. Lathe Forming Attachment for Tire Mold

one used on the taper turner and a steel block *E* fastened to the front of the cross-slide was given sufficient overhang so that a connection could be made with the rod by the nut and washer at *S*. The brackets *Q* at the rear of the lathe were screwed to a finished pad at *R* and the plate *P* was tongued to fit them and screwed in place. The brackets were a part of the old attachment, but the plate was made up for the new arrangement. The adjustable plate *O* was drawn up on the dovetailed portion by the two square-head set-screws shown, and the forming plate *N* was of hardened steel, and screwed and doweled in position. A special bracket *M* was fastened to the rear of the carriage, and it carried at its outer end a screw *L* by which variations in the stiffness of the spring *K* could be quickly made. Incidentally it is well to note that this spring was of 3/16-inch square section, and very stiff.

The rod *F* was milled off at *G* to give a seat for the head of the stud on which the roller *H* was mounted, and for the collar and nut at *J* which held it in position. Attention is called to the fact that the form generated by this attachment is positive, for the thrust of the cutting tool has a tendency to carry the roll against the form, and it is assisted by the action of the spring so that no variations in the contour can develop due to an imperfect contact between the roll and the forming plate. An attachment of this kind will be found useful for many purposes, and the upkeep is low. Forming plates of various contours can be readily applied, and for ordinary conditions no other parts will be required.

Cheap Forming Attachment for an Engine Lathe

The work shown at *A* in Fig. 3 is of cast iron and it is required to form the contour shown to a rough approximation of the size, no great amount of accuracy being called for, however, and the quality of finish not being particular, the important point being that a certain amount of clearance must be obtained. The machine selected for the work was an engine lathe, and the attachments were made up as cheaply as possible. The work was held by the outside in the jaws *B* of a three-jaw geared scroll chuck, and the tool *C* was held in the regular manner in a toolpost *D* on the cross-slide of the lathe. The tool was formed to a perfect radius on the end so that the form would not be affected by the constantly changing cutting faces presented to the work.

A special bracket *J* was fastened to the inner ways of the lathe by means of screws and straps on the under side, these not being shown in the illustration. Longitudinal adjustment could therefore be readily made to compensate for slight errors in the setting. On the bracket a hardened steel plate *H* was screwed and doweled, this plate being formed to a contour determined by a line through which the center of the roll would pass in generating the required form. This point is of importance and should not be overlooked in laying out a cam-plate. A bracket *E* is mounted on the cross-slide and held in position by the two screws *F* which enter shoes in the tee-slots of the cross-slide. At the outer end of this bracket is a roller *G* which is of tool steel, hardened and ground and mounted on a stud secured in the end of the bracket.

When this device is put in action the tool is started at the center, the cross-slide feeding outward while the operator holds the roll in contact with the forming plate with continued pressure on the longitudinal feed handwheel. The greatest objection to a forming attachment of this kind is that the operator is a somewhat uncertain quantity and may fail to keep the roll in contact with the form under all conditions. In the case of the kind mentioned slight variation was of no great consequence so that no trouble was experienced from this source.

Another Lathe Forming Attachment

The work shown at *A* in Fig. 4 is a steel casting requiring an internally generated radius together with an external taper. The work has been previously machined and is located by a finished surface, the faceplate *B* being screwed onto the spindle *D* in the usual manner for this purpose. Screws *C* are passed through previously drilled holes in the casting

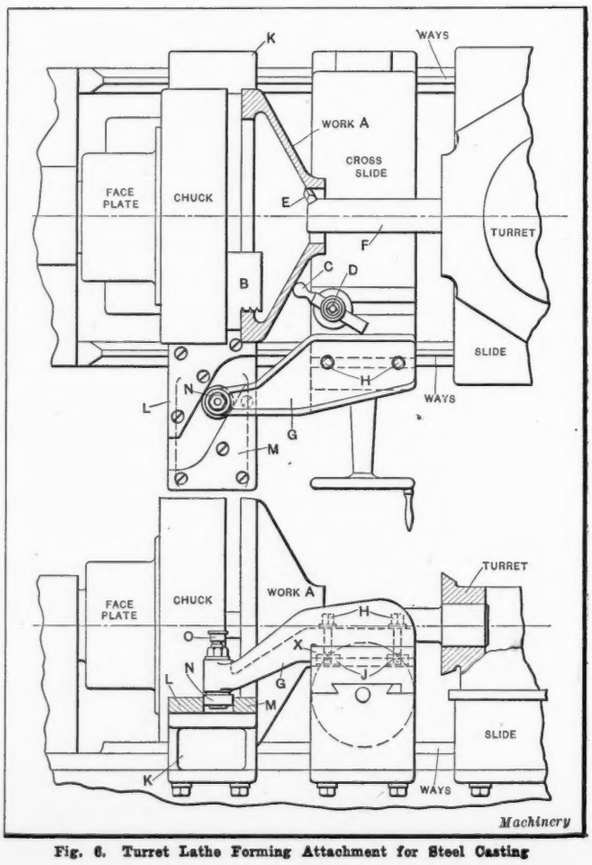

Fig. 6. Turret Lathe Forming Attachment for Steel Casting

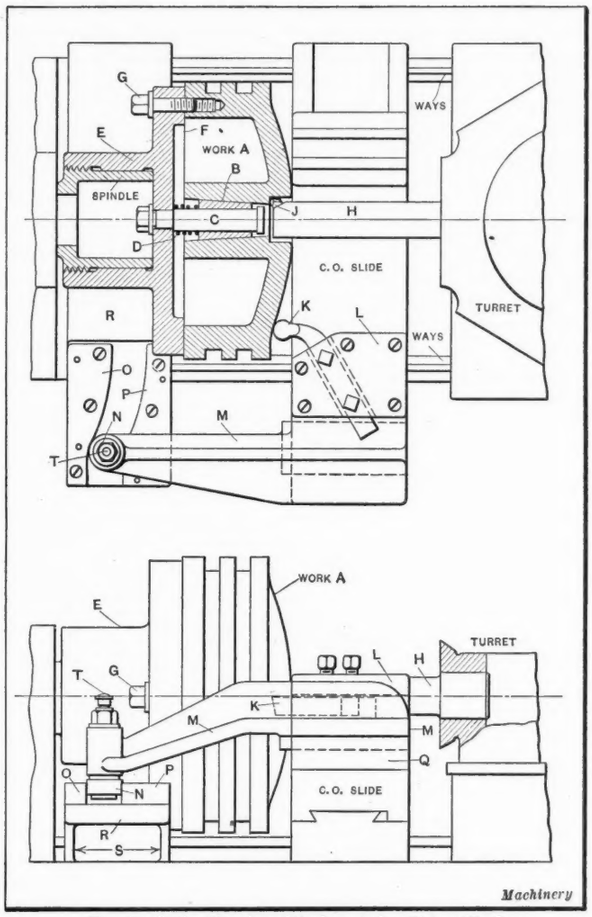

Fig. 7. Lathe Forming Attachment for Piston Head

to draw the work against the faceplate. The tool *E* is formed to a radius on the cutting end, and is mounted in the special tool-block *F*, which is located on the cross-slide of the machine. An overhanging end *G* on the tool-block supports a roller of tool steel which is hardened and ground and revolves on a pin in the end of the bracket.

A special steel holder *K* is split on the upper side and bored to fit the tailstock spindle *M*, being clamped thereto by the screw *L*. A portion of the holder *K* is slotted to receive the forming plate *J*, the contour of which determines the form of the finished work. This attachment is subject to the same objections as that shown in the previous instance and variations in the form are likely to be occasioned by the carelessness of the operator. In addition to this there is always a possibility of a slightly angular setting of the forming plate carrier which may result in slight errors or variations in the form. The attachment can, however, be made up cheaply and can be adapted to a great variety of uses by the simple expedient of making up a forming plate to suit the contour desired.

Lathe Forming Attachment for a Tire Mold

The machining of tire molds involves several points which are not usually considered in forming operations. In the first place, they are usually made of chilled cast iron or cast steel with a finish allowance in the mold cavity of from ¼ to ⅜ inch. This requires the removal of a considerable amount of very hard stock, and the limits of accuracy required in the finished work are very close. The finished surface must be as smooth as glass and highly polished.

The work shown at *A* in Fig. 5 is half of one of these molds, and the machine upon which the forming is done is a special short-bed lathe of large swing. The work is held by the inside in the jaws *B* of the three-jawed gibbed scroll chuck, and a driver is provided on the inside of the mold ring so that it comes in contact with the side of the jaw and assists in carrying the work along. The tool *C* is mounted in a revolving toolpost on the front of the cross-slide and is formed to a radius on the cutting end. On the other side of the toolpost a steel roll holder *E* is fastened which carries the hardened steel roll *F*. In order to generate the desired form in the mold cavity, the center of this roll must follow the path shown by the dotted line *N*, and the plate which controls the form must be so shaped as to carry the center of the roll along this path. This plate *H* is of tool steel and is located against the shoulder on the bracket *J*. This bracket is of cast iron and extends completely across the ways and is gibbed underneath by two straps which are held there by the screws *K*.

Positive contact of the roll with the forming plate is assured by the cable *M* which is fastened into a ring bolt *L* in the side of the carriage, the other end of the cable being attached to a heavy weight. The cable passes over a grooved pulley at the end of the lathe. As it is not possible to form the clincher portion of the mold by means of the roll, other tools are provided for this purpose. A final sweeping cut is taken in the mold cavity by the forming tool *G* which both smooths and polishes the work to the required finish.

Turret Lathe Forming Attachment

The steel casting shown at *A* in Fig. 6 has an angular external surface in combination with two curved portions. The machine on which this work is done is a horizontal turret lathe of standard make, and the casting is held by the inside in the special jaws *B* of a geared scroll chuck. The tool *C* is formed to a radius on the end in the usual manner, and is held in a regular toolpost *D* on the front of the cut-off slide. A cast-iron bracket *K* extends across the ways from side to side and is dropped down to give clearance for the chuck. This bracket is adjustable longitudinally along the ways, and is gibbed to them by straps on the under side. The front end of this bracket extends a considerable distance beyond the ways and is ribbed underneath to give sufficient strength. The two plates *L* and *M* are fastened to a finished pad on the top of the bracket and are cut out so as to form a path by which the correct contour is generated. A hardened and ground steel roll *N* is located at the end of the bracket *G* and is provided with a refinement in the shape of an oiler *O* at the top of the stud on which it revolves. The other end of the bracket is finished and tongued on the under

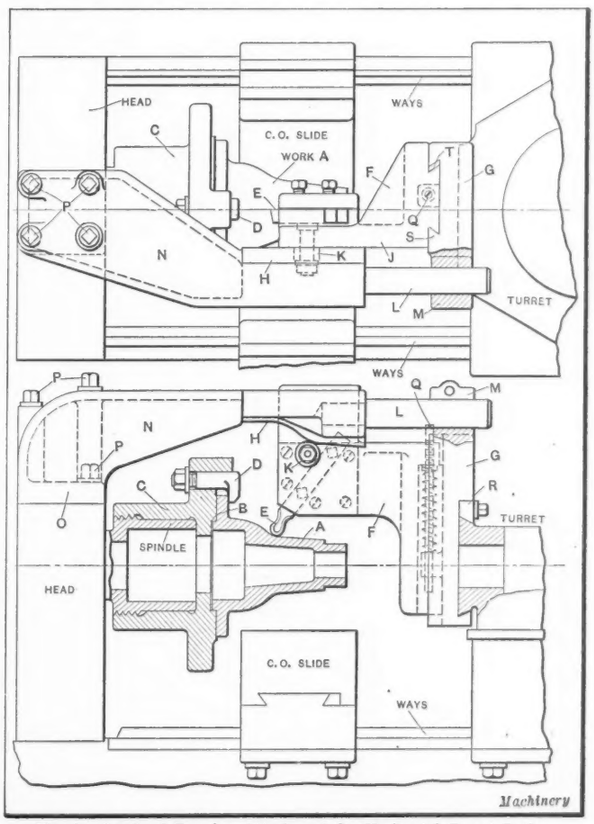

Fig. 8. Overhead Forming Attachment for Horizontal Turret Lathe

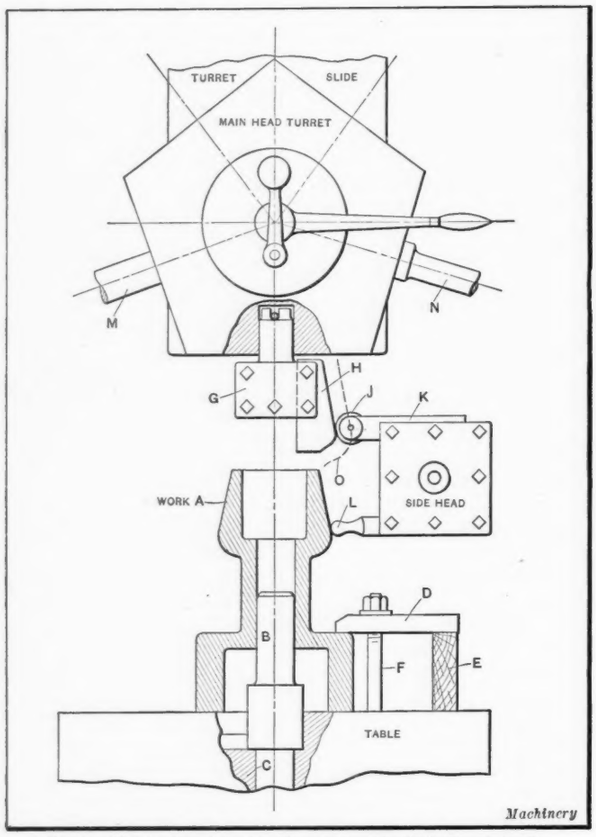

Fig. 9. Simple Forming Attachment for Vertical Turret Lathe

side to fit the tee-slot on the front of the cut-off slide, and it is held in position by the two screws *H* which draw it down firmly by means of the shoes *J*. The bracket has a heel at *X* which takes the thrust of the roll so that no shifting of the bracket is possible during the working of the device. In the operation of this mechanism both hand and power feed are used, hand feed being employed to form the two radius portions, while a cross-feed of the machine takes care of the angular part. It will be noted that although there are two plates so shaped as to give the desired form, the plate *M* is the one by which the contour is generated, the other simply acting as a guard. During the process of machining the irregular portion the turret is utilized to bore the hole by means of the bar *F* having a tool *E* at the forward end. The application of a device of this kind is suitable to many conditions and will be found very useful on horizontal turret lathe work. In using this attachment it is well to note that the longitudinal feed-screw on the under side of the cut-off slide must be either removed or disengaged, depending on the construction of this portion of the lathe.

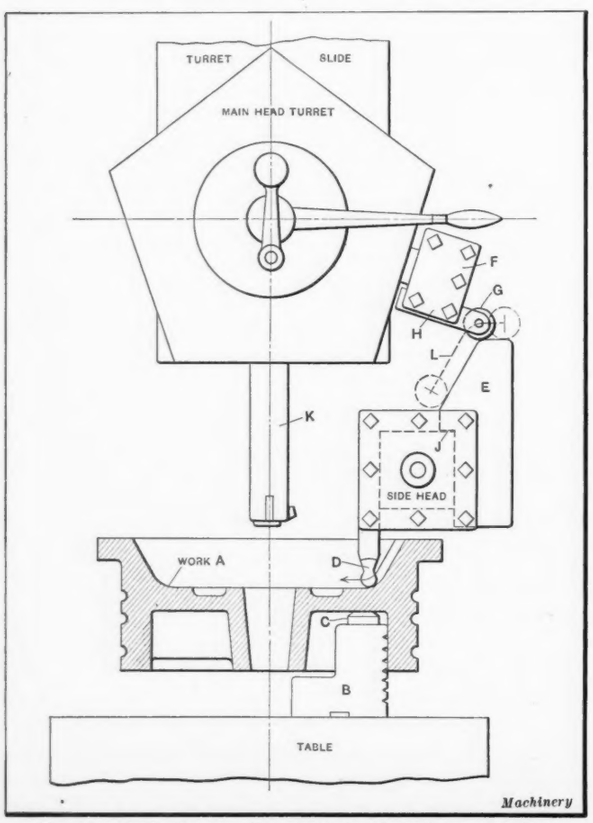

Fig. 10. Simple Forming Attachment for Vertical Turret Lathe

Forming Attachment for a Piston Head

The work *A* shown in Fig. 7 is a cast-iron piston head which has been previously machined on the open side and had the taper hole bored and reamed. In addition to this several holes have been drilled and tapped on the rim. As it is necessary to locate the work from the previously finished surfaces, some method of locating must be used which will take into consideration slight variations between the tapered hole and the finished face of the casting. A special faceplate *E* is screwed to the end of the spindle and is provided with a stud *C* on which a sliding taper bushing *B* is located, this

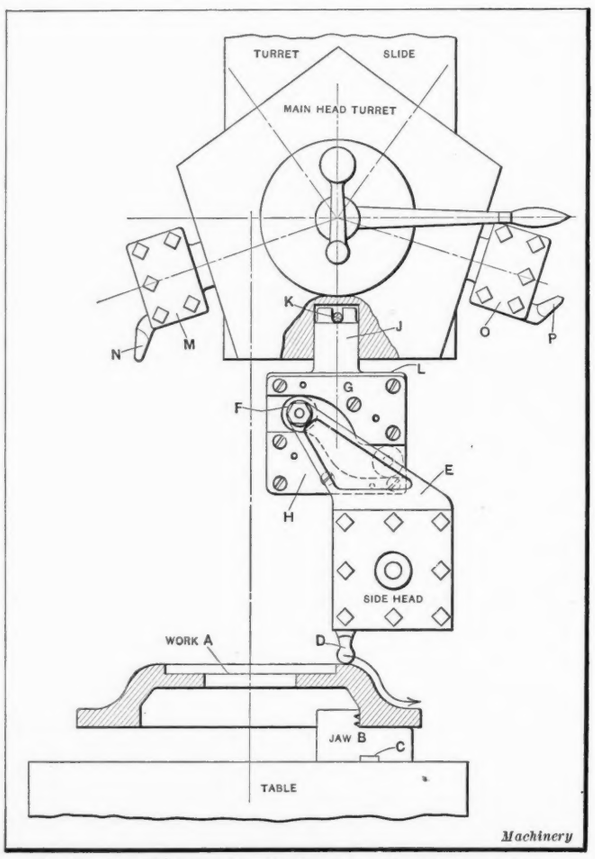

Fig. 11. Box Plate Forming Attachment for Vertical Turret Lathe

bushing being forced outward by the action of the coil spring *D* so that the location of the work from the taper is always insured even though there may be slight inaccuracies between the taper and the faced end of the casting. The screws *G* are used to draw the work back against the finished face of the plate and also to act as drivers.

This attachment is considerably different from the one illustrated in Fig. 6, as it is not necessary to disconnect the longitudinal feed-screw in order to put it into use. A cast-iron base *Q* is located on the front of the cut-off slide, and is tongued on its under side to fit the tee-slot, being held down on the finished surface by screws and shoes in the slots. The upper portion of this base is dovetailed to fit the under side of the sliding portion *M*, and is provided with an adjustable

taper gib to take care of wear. The forward part of the sliding member is slotted to receive the tool *K* which is round-nosed for the reason stated previously, and a steel block *L* acts as a cover plate and a medium to receive the holding-down screws. The outer end of the bracket arm *M* contains a hub or boss in which is located the stud which forms a bearing for the cam roll *N*, this roll being of tool steel hardened and ground. An oiler is provided at *T* as in the previous instance.

A cast-iron bracket *R* is fastened to the ways and overhangs them to a considerable extent at the front of the machine, but being well ribbed at *S* the rigidity is not impaired. On a finished pad at the upper part of the bracket, the two plates *O* and *P* are located, and these control the shape of the surface to be formed, one of them, however, giving the form while the other acts simply as a guard. In connection with the forming of the irregular surface, the turret tools are used to finish out the pocket, one of these tools *J* in the boring-bar *H* being shown at work in the illustrations. A device of this kind is very good for work not requiring a high degree of accuracy, but slight variations and ridges in the machined surface are apt to appear from time to time because the roll will fluctuate between the forming plate and the guard. If a coil spring is provided of sufficient strength to keep the roll in positive contact with the cam at all times,

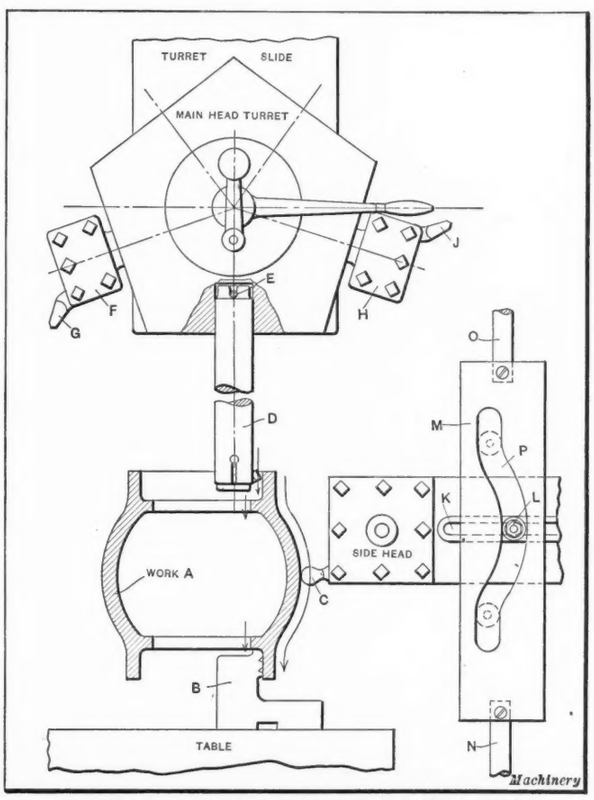

Fig. 12. Forming Attachment for Vertical Turret Lathe

the action of the attachment can be made perfectly satisfactory.

Overhead Forming Attachment for a Horizontal Turret Lathe

A departure from the methods generally used is shown in Fig. 8, the attachment in this instance being used in the vertical plane instead of the horizontal. This attachment was made over thirty years ago and although it has been subjected to considerable abuse during this time it is still in existence, and not only that, it is in working order and in use on the average about three months in the year. It has been repaired a number of times, and slight changes have been made in it, but it is still, to all intents and purposes, the same attachment that was originally made.

The steel forging *A* has been previously partly machined, and it is located for the operation shown by the shoulder *B*

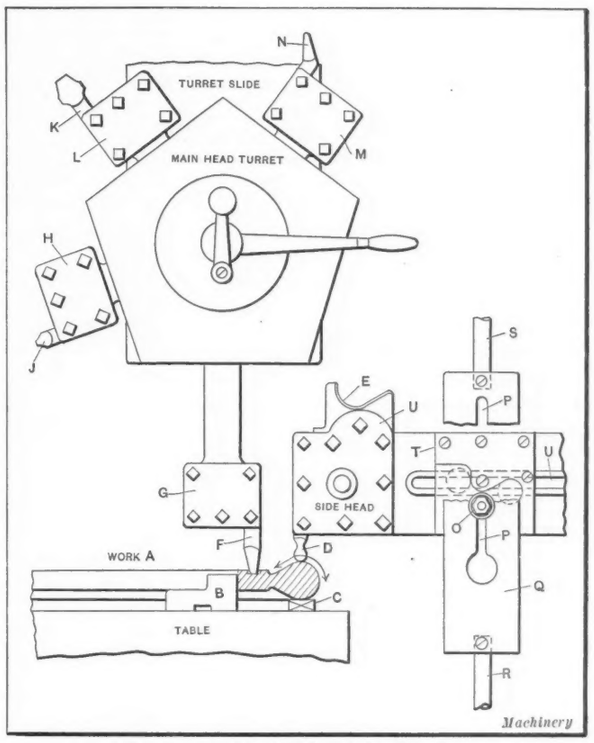

Fig. 13. Forming Attachment for Tire Core

and its adjacent face, a special faceplate *C* being utilized for holding the work. Three hook-bolts are employed for clamping the piece, one of these being indicated at *D* in the illustration. Attention is called to the manner in which these hook-bolts are backed up by the lug so that there is no danger of springing them when set up on the work. The tool *E* by which the exterior of the work is machined is carried in a slot on the sliding member *F*, and is held in place by the square-head set-screws in the steel cap which is screwed to the sliding member. A hardened and ground steel roller *K* is mounted on a stud on the front of the slide and this follows a form cut on the edge of the steel plate *H* by which the desired contour is produced. A box-section bracket *N* is screwed to the finished surface of the spindle cap *O* by the screws *P*, and to this the forming plate is attached. A pilot *L* is placed at the forward end of the bracket in order to obtain greater rigidity, and this enters a split boss *M* on the fixed member *G* which fits the turret dovetail and is gibbed thereto by the angular gib *R*. The surface of the sliding mem-

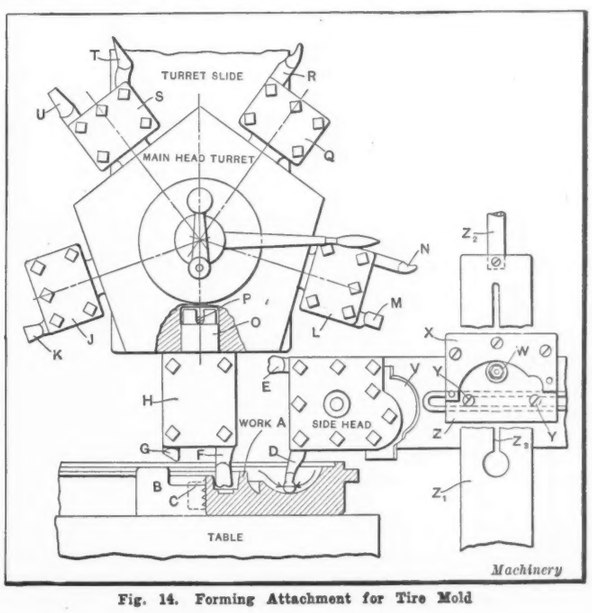

Fig. 14. Forming Attachment for Tire Mold

ber *F* is a nice sliding fit on the back of the steel forming plate and assists in stiffening the entire mechanism as the thrust of the tool carries it against the plate and prevents vibration, by giving it a solid surface to slide upon. The sliding member *F* is dovetailed at *S* and *T* to fit the member *G* and is furnished with a taper gib *T* for adjustment. In order to insure a positive contact between the roll and the forming plate at all times a stiff coil spring is pocketed in a recess between the two members, and a means of adjustment is provided in the screw *Q* so that the desired compression can be obtained with little trouble. The operation of the device is obvious, but attention is called to the fact that the thrust of the cut tends to carry the roll against the forming plate instead of in a contrary direction, so that the contour is always positively insured.

Simple Forming Attachment for a Vertical Turret Lathe

In the application of forming attachments to the vertical turret lathe and vertical boring mill, due consideration must be given to the fact that these machines are generally used for work of the heavier variety, and that as a consequence all attachments are subjected to greater stresses because of the heavier cuts which are naturally taken on these machines. In view of these facts it is well to make all fixtures and devices of such section that the factor of safety will be ample to take care of both use and abuse.

A very simple arrangement for forming an irregular contour is illustrated in Fig. 9, the work *A* being of cast steel which has been partially machined in a previous operation. A centering plug of steel is fitted at *C* to the center hole in the table, and is finished at *B* to the size of the previously machined hole. The work is slipped onto the stud until the finished face of the large end of the hub rests on the top of the table. A set of three U-straps *D* are used to hold the work down on the table, by means of the tee-bolts *F* which enter the tee-slots in the table, the outer ends of the clamps being supported by wood blocks *E*. The tool *L* is of the round-nosed variety previously mentioned, and is held by the screws in the side head turret. In opposition to the tool is a roll-holder *K* which is provided with a hardened steel roller *J*. A tool-holder *G* of the regular type furnished with these machines is used as a support for the forming plate *H* which is so proportioned as to generate the desired form when its edge is in contact with the roller in the side head. It must always be borne in mind that the *outline* of the formed plate must be such that it will cause the *center of the roll* to travel through the path required on the finished work, as indicated by the dotted line *O* in the illustration. Boring-bars *M* and *N* are used in this same setting of the work to rough- and finish-bore the pocket bearing at the upper end of the work.

Much depends on the operator in using a device of this kind, for unless he is particular to keep the roll in positive contact with the plate the resulting work will not be satisfactory. With a reasonable amount of care, however, excellent results can be obtained with this type of forming device, and as it is comparatively inexpensive, it may be used in many cases where the expense of a more complicated arrangement would not be permissible.

Another Simple Forming Attachment for the Vertical Turret Lathe

Another simple and inexpensive attachment is shown in Fig. 10, yet the application in this case is entirely different from that shown in Fig. 9. In the previous case the roll was held in the side head, while in this instance it is the formed plate which is so held.

The work *A* is held in its rough state by the inside of the rim in the jaws *B*, and is supported on the buttons *C* which strike the under side of the casting web. The tool *D* which generates the contour is, as usual, of the round-nose variety, and is carried in the side head. On the other side of the side head turret the forming plate *E* is clamped by means of the set-screws shown, an additional precaution against slipping being provided in the shoulder *J*, which brings up against the shoulder in the turret. The roll-holder *H* in this instance is held in a regular tool-holder *F* in the main head turret. The boring-bar shown at *K* is used for boring the tapered hole after the forming has been accomplished.

In operation, the main head is locked securely in the position shown in the illustration, the roll being in the position with relation to the side head shown by the lower dotted circle, and the tool just ready to start at the top of the casting. The forming plate in the side head is held in contact with the roll in the main head and the down-feed started, the tool taking the position shown by the arrow, and the roll changing its position in relation to the forming plate as indicated by two dotted circles, the dotted line *L* indicating the path of the roll. This arrangement is open to the same objections as that shown in Fig. 9 but can be made to do good work providing reasonable care is used in this operation.

Box Plate Forming Attachment for the Vertical Turret Lathe

The work *A* shown in Fig. 11 is in its rough state and is held for the operation of forming and machining by the inside of the flange in the special jaws *B*, these jaws being keyed to the sub-jaws of the table by the keys *C*. A round-nose tool *D* is used to generate the contour, the tool being held during the operation in the side head of the machine. A special roll-holder *E* is fastened on the upper side of the side head by the regular screws, and has a shoulder which thrusts against the head so that no change of location can occur during the progress of the work. A special holder *L*

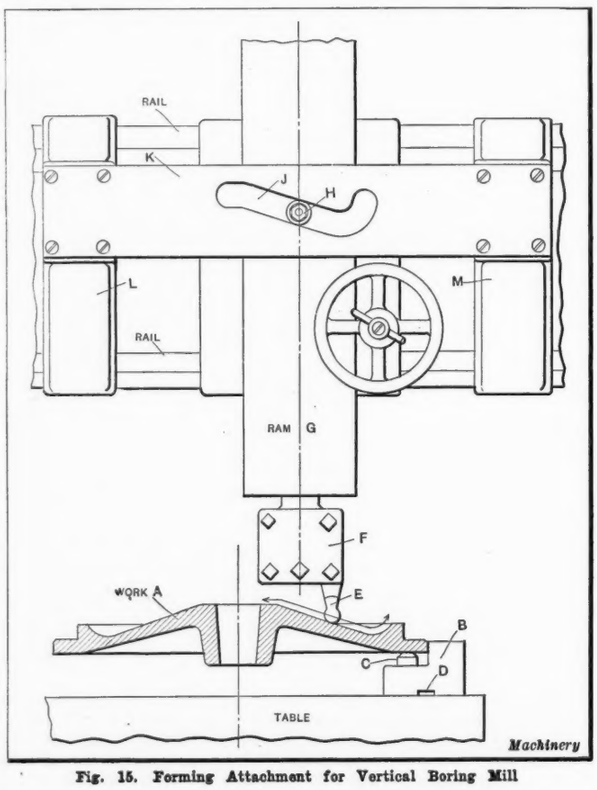

Fig. 15. Forming Attachment for Vertical Boring Mill

has a shank *J* which enters the main head turret hole, and is prevented from turning by the pin *K*. The plate *G* is of steel and is screwed to the face of the holder and doweled in position, its lower contour being such as to produce the desired form on the work. The lower plate *H* acts as a guard and prevents the tool from dropping too low and gouging into the work.

This device is operated partly by hand feed and partly by power, the roll *F* being forced against the upper cam surface by the operator. The tools *N* and *P* in the tool-holders *M* and *O* are used for roughing out and finishing the inside work on the casting as well as boring the hole. For work not requiring a very high degree of accuracy, a plate cam of this sort with its attending guard gives very good results.

Another Forming Attachment for the Vertical Turret Lathe

In order to obtain the greatest efficiency from a machine of this type it is highly desirable to keep both the main head and side head in operation as continuously as possible. The forming attachments which have been shown for this ma-

chine have all been open to the objection that one of the heads was inoperative during the forming operation. In the arrangement shown in Fig. 12 the attachment is a special one supplied by the Bullard Machine Tool Co., manufacturer of the vertical turret lathe, and being independent of either head it allows both to be used simultaneously. The work *A* is held by the inside of the lower flange in the special jaws *B*. The round-nose tool *C* is held in the side head turret as shown in the illustration. A tee-slot *K* is cut along the full length of the ram, and in this slot a special stud containing a roll *L* may be moved into any position required by the work in hand. The forming plate *M* is supported at each end on the rods *O* and *N* which are vertically adjustable in brackets fastened to the bed of the machine. The required form *P* is cut in the plate, and the side head down-feed being thrown into engagement the roll *L* follows the slot in the plate, thereby causing the tool *C* to follow the line indicated by the arrow.

While this operation is in progress the boring-bar *D* in the main head turret may be used to bore the surfaces indicated by the arrows, and the tools *G* and *J* in their respective tool-

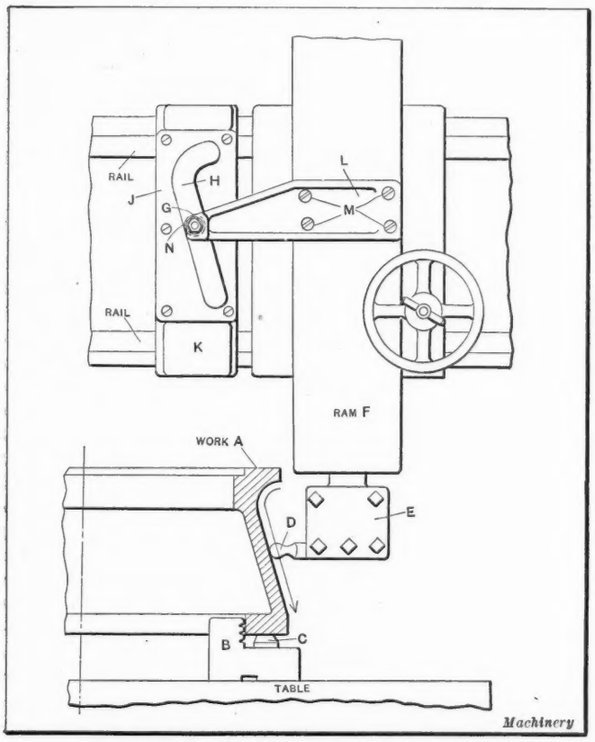

Fig. 16. Forming Attachment for Vertical Boring Mill

holders *F* and *H* can also be utilized for facing, so that there is no lost time necessary when this device is being used.

Forming Attachment for a Tire Core

Another attachment which allows the independent use of both heads simultaneously is shown in Fig. 13, the work in this instance being a tire core of chilled cast iron. The operation of this device is just the opposite of the usual forming attachment, for the roll *O* is held stationary in a slot *P* of the plate *Q*. This plate is supported at each end by the rods *S* and *R* which are adjustable vertically in brackets on the bed of the machine. A forming plate *T* is located on the side head ram and is held in any desired position by tee-bolts which enter the slots *U* in the ram. It will be noted that the form of this plate appears to be such that it will not produce the work shown, but if it be remembered that the plate moves while the roll stands still the matter will be more easily understood. In using the device the operator keeps pressure on the roll by means of the down-feed crank on the side head, being careful that positive contact is kept at all times. The tool *F* in a special length tool-holder *G* roughs out the grooves in the core. The tool *J* in the holder *H* rounds the corners; the tool *K* in holder *L* finishes out the bevel groove; and tool *N* in holder *M* makes the fillet. Attention is called to the fact that the work *A* is set up on small steel blocks *C* and is gripped by the inner rim in the jaws *B*. The final finishing for the first operation on the core is done by the sweep tool *E*, the machine being reversed during this operation in order to take advantage of the slight spring which this reversal gives, so that the action in sweeping is somewhat similar to that of a goose-neck tool and gives a very smooth contour to the work and a mirror-like finish perfectly free from chatter.

Forming Attachment for a Tire Mold

The work shown at *A* in Fig. 14 is a tire mold of larger diameter and more complicated structure than the one previously illustrated in Fig. 5. The forming attachment used for this work is the same as that shown in Fig. 13 but its application is somewhat different. The work itself is held by the inside in the jaws *B*, a driver *C* being cast on the inside of the rim in order to relieve the jaws of some of the strain incident to holding a piece of this character under very severe machining conditions. A special round-nose tool *D* is used to rough out the mold cavity, the form of which is controlled by the contour of the plate *X*. This plate is mounted on a supplementary one *Z* which is secured in position by the screws *Y* in the side head ram tee-slots. The plate Z_1 is supported by rods as in the former instance, one of these being shown at Z_2. The roll *W* follows the contour *X* and is supported in the slot Z_3 as in the preceding case. A sweep tool *V* is used to finish out the mold cavity after reversing the machine, as on the core work. The tool *F* in a special holder *H* roughs out the angular pocket where it is shown at work, and the tool *G* cuts out the recess at the outer portion of the mold. The tool *K* in the holder *J* sizes the groove in the angular pocket while *U* in the holder *S* trims up the angular sides. The pointed tool *T* is used as a marker at the bottom of the mold cavity. The tools *R* and *N* in the holders *Q* and *L* rough and finish the clincher portion of the mold, while the facing tool *M* finishes the shoulder of the recess.

Forming Attachment for a Vertical Boring Mill

The application of forming attachments for machines of this character are somewhat unusual but are nevertheless needed on certain classes of work or when other machines in the shop are so tied up that they cannot be spared. The work *A* shown in Fig. 15 is a center for a Mallet locomotive piston head, and is held by the outside in the jaws *B* being supported at three points on raising buttons *C*. A round-nose tool *E* is held in the regular holder *F* which is placed in the ram *G* of the right-hand head. Two brackets *L* and *M* are gibbed to the upper and lower rails as shown. These brackets carry a plate *K* which is cut out at *J* to the form required to generate the desired contour. A stud screwed into the ram supports the roll *H* which bears against the edge of the plate and causes the tool to take a similar path.

Another Forming Attachment for a Vertical Boring Mill

When forming is required in a vertical plane and the work is to be done on a vertical boring mill it becomes necessary to disconnect the horizontal feed-shaft on the ram. A special nut is required for this purpose somewhat on the principle of a lathe lead-screw nut. The work shown at *A* in Fig. 16 is an example of a piece which requires this change in the machine. The work is held by the inside of the lower flange in the jaws *B* and is supported at three points on the buttons *C*. A special bracket *K* is mounted on the upper and lower rails of the machine and on this bracket the forming plate *J* is fastened by means of screws and dowels. The plate is cut out to the form *H* which controls the path of the tool *D* through the medium of the roll *G*. A bracket *L* is attached to the ram by means of the screws *M* and the end of the bracket is slotted at *N* to allow the rapid removal of the stud on which the roller *G* is mounted. An attachment of this kind can be readily applied to nearly any standard make of boring mill and will give very satisfactory results if properly used.

Great care must be used in designing brackets for heavy work of this character. They must be made of very heavy construction so that all chance for vibration will be eliminated.

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THE RIGHTS OF SPECIAL MACHINERY BUILDERS

In building special machinery the manufacturer is often confronted by a question of commercial ethics. He is called upon, for example, to build a special machine based on ideas furnished by his customer, but in working out the design the builder usually develops a number of additional ideas of his own. Later he may be approached by a competitor of the first customer, who wants a special machine built for similar work. To what extent is he justified in using the ideas employed in the first machine when building the second one?

If the complete drawings and all the ideas for the first machine were furnished by the customer, the builder would certainly have no right to construct an identical machine for a competitor; but that is seldom the case. Builders of special machinery are more than anything else developers of ideas in connection with their product, and in the building of machines for one customer they necessarily gain experience which may be used greatly to the advantage of another. To what extent this experience may be legitimately employed in the construction of such machinery is a question upon which makers of special machinery and those who order it do not quite agree.

Perhaps the rights of the builder may be more easily defined by comparing him with an employe who gains a great deal of valuable experience when engaged on special work. It is quite evident that after changing his position he will make use of that experience for another employer, and it is conceded that such use is a natural right. Is not the builder of special machinery in a similar position? Has he not the right to use the experience gained working for one customer in the building of machines later for others; if not, where should the line be drawn?

* * *

BALL AND ROLLER BEARINGS IN LIGHT MACHINERY

Ball and roller bearings are used in machinery almost universally for the purpose of reducing the frictional resistance and thus increasing mechanical efficiency. But they may be applied to light machines for another important purpose—to eliminate the necessity for frequent lubrication. The bearings of light machines used in homes and offices are generally neglected, oiling being irregularly done. If oiled too much, the bearings are likely to become dirty and gummed, causing undue friction. Cleaning the bearings is a dirty, disagreeable job, out of keeping with the surroundings of the home or office, and is generally put off as long as possible.

Office appliances, dictating machines, adding machines, typewriters and other machines used in the office which have no rapidly moving parts could advantageously be provided with ball bearings mounted in sealed races. If the races were filled with vaseline or other heavy lubricant, the bearings running at slow speed could be operated indefinitely without damage. Machines thus equipped would never require oiling, and seldom cleaning, during their working life.

The idea is slowly gaining ground that oiling machinery is not necessarily a function that must be performed by an attendant. This is noticeable in the design of high-speed engines, turbines, machine tools, etc. In high-speed, heavy machines of these types, lubrication is effected by systems of pipes and circulating pumps which insure copious supplies of cool oil to the bearings. The use of anti-friction bearings in light machinery for the purpose of eliminating the trouble of lubricating the bearings is but another logical application of the idea of saving labor and insuring uniform and dependable lubrication. The mechanic may be inclined to sneer at the idea of building machines with no provision for lubrication, but the practical business man who has had experience in the sale and maintenance of such appliances knows that neglect is practically universal, and having to face the fact, it is better to provide against it by making bearings "neglect-proof."

* * *

RATIONAL PUNCH AND DIE DESIGN

The development of sheet-metal-working tools has played an important part in modern manufacturing methods, but there is still room for improvement, especially in the application of the knowledge acquired. It is practically impossible to find definite information on some phases of sheet-metal working. It is true that certain manufacturing concerns have collected considerable information on this subject, but few have put this matter into such shape that it can be used as a rational working basis to eliminate costly experimenting when something new comes up. General formulas have been developed for determining the approximate amount of reduction in the drawing of shells and cups; but the results obtained vary with different metals, and experimental designs are necessary to obtain satisfactory results. Diemakers believe that there are conditions in this branch of metal-working which defy analysis, and "experience" seems to them to be the only reliable guide. This is not creditable to the sheet-metal-working industry, considering its importance and the large savings that might be made.

The ductility of the material to be worked, commonly referred to as hardness, is an important factor. When the kind of material, its hardness and elastic limit are known, the other data required for rational design should readily be deduced from practice. The available hardness testing devices have not been used to an extent that their usefulness may warrant.

An improvement which could be made in punch and die design is the standardization of certain parts. There is no apparently valid reason why certain parts of ordinary press tools such as bolsters, die pins, bushings, punches, stops, tripping and feeding devices could not be made to standard shapes with resulting reductions in first costs. Now each designer apparently works to his own ideas, the result being a multiplicity of designs throughout the sheet-metal industry, some of which are low-priced and efficient while others are inefficient and costly.

The literature on punch and die work is by no means complete. Many articles have been published descriptive of punch and die design, some of them interesting and valuable, but the lack of material dealing with fundamental principles and analysis is apparent. More analytical articles dealing with basic principles are needed, and fewer articles describing specific examples of design. MACHINERY has undertaken to compile available data and will publish the results of investigations in a series of articles now in preparation.

SOUTH AMERICAN MARKETS FOR MACHINE TOOLS*

THE FIELD FOR MACHINE TOOLS IN SOUTH AMERICA AND METHODS OF OBTAINING ORDERS

BY B. OLNEY HOUGH†

MANY American machine tool manufacturers seem inclined to dismiss possibilities of trade in South America with a more or less contemptuous shrug; a few, on the other hand, think, or at least talk, in an exaggerated fashion of the wonderful prospects awaiting them in that part of the world. The truth of the matter is that there is undoubtedly an attractive and regular market for many of our commoner, simpler tools in the principal South American countries, while the gradual development of others of those countries is bound to come sooner or later, as native industries expand, internal communications are promoted, and population increases. As those markets exist today, there are certain peculiar features affecting possible trade in machine tools which it is important to understand, because they affect the methods of cultivating that trade, differentiating them in some respects from other markets with which American tool builders are perhaps more familiar. But, before we go any farther, we may well stop to remind ourselves of a number of misapprehensions which are provokingly widespread just now.

First, there is no lack of ships to South American markets. Any manufacturer who has machinery or anything else to send will have no difficulty in finding a ship to take them. Ships are leaving New York, Mobile, New Orleans and the Pacific Coast ports with usual regularity, and reaching every seaport of commercial importance.

Second, the theory that we must give the "long credits," which the Germans are said to have done, has been thoroughly discredited, and most people now know that these long credits were in the great majority of cases nothing more than ordinary drafts at ninety days' sight, paper which any American house of good standing can sell for cash to foreign exchange bankers, now as heretofore, with only this complication: because of the disruption of the international exchanges following the outbreak of war in Europe, a certain degree of patience may be required in finding those particular banks offering to handle the paper on advantageous terms. Some of the bankers who in normal times have been seeking this business have now, for reasons of their own, or for reasons beyond their control, curtailed their business with Latin markets. It is true, of course, that in exceptional cases machine tools, like other products, have been sold on more liberal terms, ranging up to possibly five or six months' credit, but with the Germans or the English, or any other nation, terms of this sort have been exceptional, and have been granted only in cases and under conditions where Americans as well as Europeans are willing and glad to offer similar accommodation.

Third, machine tool makers, more than any other class of American manufacturers, have to depend on catalogues, printed matter, photographs, specifications, and proposals. You cannot take a sample of a lathe along with you in a trunk when you go to visit Latin-American prospects; so a good deal of the advice so liberally offered to American exporters as to the impossibility of doing business in Latin markets in any other way than through a traveling salesman may be disregarded by machine tool houses. They must depend largely, but not exclusively, on advertising and on correspondence.

Finally, while the acknowledged economic embarrassments of certain South American governments undoubtedly may, for the moment, operate to restrict immediate purchases, American manufacturers in this line, above all others, have to look to the future, to make plans for the days bound to come before long when purchases of new equipment will be imperative. No buyer of machine tools in Latin America or in any other part of the world will or can place orders with unknown manufacturers, or for tools which he has never heard of or has not had an opportunity of studying thoroughly. Hence, because prospects are distinctly encouraging in the principal South American republics, especially those of the East Coast, it is emphatically the part of the progressive and aggressive manufacturer to take immediate steps to let possible buyers and users of the tools he manufactures know all about them, to impress these prospects duly with the peculiar qualities and advantages of the tools offered. The maker cannot wait until the identical day, the very week or month, when the tool will be required.

The Field for Machine Tools

It is not to be denied that in some of the markets we are now considering business is likely to be occasional, rather than regular, and it is the user of tools more frequently than the tool merchant who is the buyer. While at two or three of the principal towns of Brazil, at Buenos Aires and a few other points, there are established merchants doing a regular business in machine tools, possibly carrying some of the commoner forms in stock, yet the greatest field for the machine tool manufacturer is with the actual users of tools, chief among them the railway shops. There are railways of more or less importance in every one of the South American republics. Some of them have fairly big shops, employing as many as 1500 or 2000 hands each. If, in some instances, the railways are of small account, perhaps having only forty or fifty hands to a shop, yet all use machine tools, need new ones from time to time, and, with the growth of territories which they serve and the extension of their lines, must contemplate every now and then new shops or the enlargement of old ones.

There are some rather important shipyards in South America. There are also mines of all sorts and sizes, and everywhere electric light and power plants. There are sugar mills in some territories which have to maintain their own little machine shops. Everywhere there are boiler shops and general repair shops, and technical schools which have some of the commoner tools in their shops and want to know all about all sorts of tools. The rapid and continuous growth in the use of automobiles and motor boats is contributing in important degree to the increased demand by repair shops for suitable tools. On the other hand it is not to be denied that the boiler and machine shops, which of course must exist in every community of the least importance, are (in the great majority of cases) exceedingly small and boast little more, perhaps, than a forge and a foot power lathe. Moreover, the supremely ignorant and unskilled labor which they can command, may retard for some time the introduction of more complicated machinery.

Granted the primitive character of the overwhelming proportion of so-called machine and repair shops throughout South America, none the less the continent remains an important and promising field for up-to-date machine tools. The railways alone, in their construction work and in their repair shops, require in the aggregate a considerable number of tools. Most of those that have thus far been installed come from the United States. British tools are a close second to us, partly because of the nationality of the railways' engineering forces or the character of the financing of the companies. In recent years Germany has been making increased and successful efforts to secure a part of this trade. For the moment Germany can, of course, do nothing, and whatever the result of the war in Europe may be, it seems quite certain that for some time after the war the many South American railways which are virtually controlled by Englishmen will not look with especial favor on tools from Germany.

South American Railways

Each one of the following railways must have at least a repair shop, and many of them maintain large construction

* For other articles on South American trade see "South American Trade Conditions" in the February, 1915, number of MACHINERY, and "The Right Way of Obtaining Foreign Trade" and "Establishment of American Banking Facilities in South America," November, 1914.

† Editor, "American Exporter," 17 Battery Place, New York City.

shops at various points. In the Argentine Republic there are two government railways. Fourteen other lines are controlled by companies most of which have headquarters in London. The operating headquarters of all but three or four are located in Buenos Aires. At Rio de Janeiro are the headquarters of eleven steam railways and seven electric railways. Headquarters for twenty-four other steam roads and about four electric roads are found at other points in the republic of Brazil. In Uruguay there is one American railroad and one partly American; five others are English companies; of two native steam roads one belongs to the government. The only important electric line is owned by a German firm.

Chile boasts 1979 miles of government railway and 1937 miles belonging to fifteen private companies. There are electric tramways in Valparaiso, Santiago and Concepcion. In Peru there are nine steam railways owned by the Peruvian Corporation and no less than nineteen other lines, some of them short, of from three to sixty miles. The railway shops in connection with these Peruvian lines employ all the way from 40 to 400 men each. Electric tramways are confined to the city of Lima. Paraguay's railways are said to be in the hands of British companies. There is but one electric line. Four steam railways in Ecuador are all owned by the government. Private companies control two electric tramways. In Colombia there are six companies operating steam railways.

In Venezuela there are ten different companies operating steam roads, three of them around Lake Maracaibo. Of the principal lines, two are English and one German. A rather curious condition exists regarding the main system of Venezuela, that is the line running from Caracas to Puerto Cabello, which is divided between two ownerships, the point of division coming about midway of the line. From Caracas half way down the management is German; from Puerto Cabello half way back, joining the German line, the road is British.

From the foregoing it must by no means be assumed that railway shops offer the only opportunities for selling machine tools in South America. As has already been intimated, there are numerous other shops which require considerable equipment, as in connection with steamship lines and dock works, for example. An important installation, made not very long ago for certain large interests in Brazil by the company which is probably acknowledged to be the largest American builder of machine tools, is an example of what is likely to happen in other South American republics.

Obtaining the Orders

The question of how to secure orders from these users of machine tools is one which undoubtedly will chiefly interest American makers who would like to obtain a share of the business. Apart from the railway shops, it is probable that the great bulk of the tools required by other shops is purchased through local concerns of the description usually characterized as "general importers." Merchants of this sort bring out from the United States and from Europe all sorts of supplies, of no matter what description, that may be required locally. Accordingly, local machine shops, like local boot and shoe shops, entrust their orders for foreign goods to the bigger local merchants who make importing their business. It may follow that anything but a good technical description of what is wanted reaches the American suppliers, since the owners and mechanics in boiler shops, or other small industries requiring a new tool of some sort, are themselves neither well educated nor highly trained, while the general importer who transmits the order, often to a New York export commission merchant, probably does not know the difference between a lathe and a drill press. To some extent this can be remedied by the freer distribution among all possible buyers of properly illustrated catalogues, which—it goes without saying—ought to be in Spanish, unless they are to go to Brazil, where people speak Portuguese and not Spanish; but it is not desirable to attempt to translate the ordinary English technical description of a tool into these languages. The American manufacturer will do well to remember the unskilled, untrained, uneducated character of the men who buy his tools as well as the men who operate them. The whole description of a tool ought to be of the simplest, most elementary character. The description, no less than the tool itself, ought to be "fool-proof." This applies, it should be understood, to the literature intended for native perusal; English catalogues will answer for British engineers of railways owned in Great Britain.

Advantages of Local Selling Agents

A rather large proportion of the various railway lines are not owned or controlled by native interests, but are either British or German organizations. This may bring about certain complications in the seeking of orders for shop equipment required by these roads. Nevertheless, as all of them buy their equipment on tender, very often tenders for commonplace tools are locally advertised. In such cases often no more than sixty days is allowed for the receipt of offers. In the majority of instances, this precludes the possibility of an American manufacturer obtaining specifications and returning bids within the time limit.

This is one reason why it is desirable that the machine tool manufacturer be represented on the ground by a competent local agent. It may not be necessary to add that there are other good reasons for making a connection with a local representative, for there are purchasing agents in Latin America who resemble some in other parts of the world, in that they should frequently be "visited" and "seen." Government and municipal enterprises can usually be sold in no other way than by those local representatives at strategic points, who are the possessors of the right sort of acquaintances and the right sort of diplomatic ability, to make offers for the American manufacturer in the right way and be able to make those offers within the time limits that may be set. Such connections of the best sort may often be secured without the necessity of a personal visit. Advertising and corresponding may be very effectively utilized.

Two Ends to be Worked

The fact that most of the largest railway lines in South America buy the largest volume of their supplies through headquarters in London virtually means that the manufacturer who wants to sell them his tools must cultivate both ends, the engineers or purchasing agents in the actual field of operation, and the buying agents in Europe. This does not always overwhelm with satisfaction the traveling man whom the American manufacturer has sent to get orders in South America, nor does it, apparently, pay his rather heavy traveling expenses. He may have worked hard and cleverly with the people he has met at the operating headquarters in the several republics and may not have sent in an order for a single tool; but if he has worked in the right way, and has called to his assistance, while he was on the ground, the best local representative that he can find, he may easily have succeeded in impressing on the engineers or the purchasing agents of the large companies, the peculiar advantages of the tools which he is offering. He may have done even more, as has been done scores of times; he may have so impressed his acquaintances with regard to his tools as to cause certain requirements to be inserted in the specifications of tenders which nobody's tools but his own can fill.

The advantages of a personal visit to the South American markets by the machine tool manufacturer or by some thoroughly competent representative are evident enough from the foregoing. Yet is is possible, so far as the railways are concerned, that orders for tools as the result of such a visit will be placed by London offices or the London buying agents for the South American roads. The manufacturer who thus attempts to cultivate South American business in South America should, therefore, follow up his effort by providing suitably strong approach to the London people from whom orders may actually come. Existing representatives in London ought to be advised to cultivate more intimately the competent London agencies of the South American interests. But the rest of the South American field for tools must by no means be forgotten or neglected. A careful, intelligently devised campaign of correspondence will be found to go a long ways, even without the help of a traveling salesman; it will, indeed, penetrate farther and reach more prospects than would be possible to any traveler. In any event, machine tool literature for South America is of vital importance.

PRESS TOOLS FOR MAKING A ROLLER BEARING CAGE*

DIES AND TOOLS USED FOR MAKING A ROLLER BEARING CAGE FROM SHEET METAL

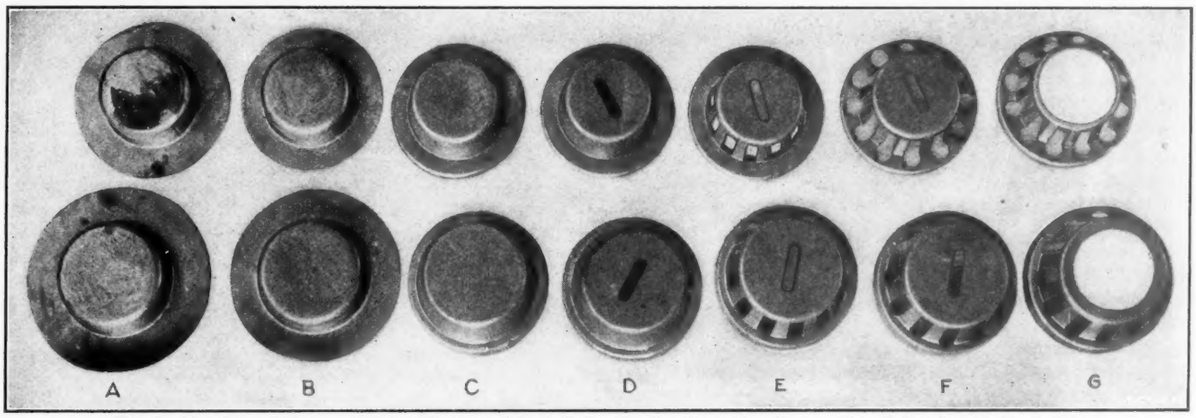


Fig. 1. Evolution of Inner and Outer Members of Bock Roller Bearing Cage—Operations performed Complete in Punch Press

THE making of a roller bearing cage from sheet metal in the punch press involves some unusual methods in press working. This particular roller bearing cage, which is patented and is one of the many sizes made by the Bock Bearing Co., Toledo, Ohio, is shown in its various sequence of operations in Fig. 1. It is made from 0.032 inch bright strip steel and is completed in seven operations. The dies and tools used in making it were designed and built by the Acklin Stamping Co., Toledo, Ohio, who also makes the stampings. This cage comprises an inner and outer section, drawn up into cone shape and serrated so that it forms,

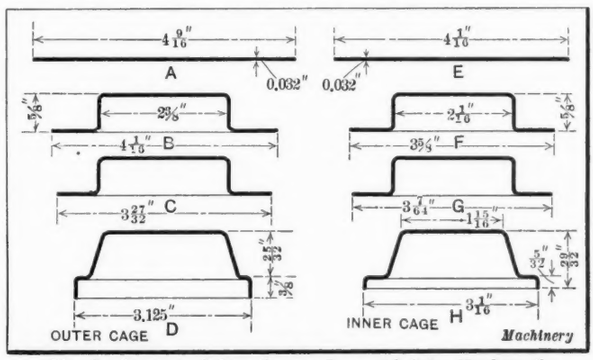


Fig. 2. Sequence of Operations on Inner and Outer Members of Bock Roller Bearing Cage

when assembled, the retainer for the tapered rollers. The cage must be made accurately and the slots through which the rollers project must be very evenly spaced. This cage is entirely completed in the punch press, not one other machining operation being necessary. As the tools for making the outer and inner members of the cage are identical in construction, only those for making the outer member will be illustrated and described in the following.

The Combination Blanking and Cupping Tools

The punch and die for performing the blanking and cupping operations, which is of the inverted type, is shown in Fig. 3, and the result of this operation is shown at *A*, Fig. 1, also at *A*, *B*, *E* and *F*, in Fig. 2. The die part *A*, Fig. 3, of this combination die, is a composite forging made from low- and high-carbon steel welded together, which is bolted to the cast-iron base *B*. This construction is commonly known as the Ferracute type. As is usual there is a rubber pressure pad underneath the bolster of the press to operate the pressure pad *C*. Particular attention should be called to the air holes in the punch and die, which facilitate the action of the die and prevent air from collecting in the stamping. One hole is located on the top of the plug *D* and two are in the knock-out pad in the punch *E*.

* For other articles on punch and die work see "Tube Making in a Punch Press" in the October, 1914, number of MACHINERY and articles there referred to.

Trimming the Cup

Before performing the subsequent operations on the outer and inner cage, it is necessary to trim the outer edge or flange of the cup. This is accomplished with the punch and die shown in Fig. 4 and in section in Fig. 5. Both die and punch in this case are composite forgings; that is, the top part of the trimming die *A* is of high-carbon steel, whereas, the lower part of the die ring is of wrought iron. It will also be noticed that the top edge of the die is sheared, which assists greatly in the ease of trimming this blank. The shear is about 1/32 inch deep, and the lands about ½ to ⅝ inch wide. Four lands are provided on this die. This is an extremely fast cutting punch and die and also a die that is easy to keep sharp and in repair. The two hook gages *B*, Fig. 4, regulate the position of the blank approximately, and the exact position is determined by the spring pad *C* on the bottom of the punch. The cutters *D* shown on the sides of the punch are worthy of note, these being two in number. As the shells are trimmed, the scrap is forced up around the punch and is gradually cut into two pieces which separates it and allows it to drop clear of the die. These knives are of crucible steel, hardened. Fig. 5 gives a better idea of the construction of this punch and die, and upon referring to this illustration it will be seen that the lower part of the trimming die is soft steel, whereas the upper part is high-carbon tool steel. It will also be seen that the spring pad *C* is held down by means of a spring surrounding the knock-out punch *E*, which is operated, of course, by a bar passing through the ram of the press. The two shearing blades are backed up by the punch body, and are held in place by cap-screws; otherwise the construction of this die is comparatively simple. The results of the trimming operation just described are shown at *B* in Fig. 1, and diagrammatically at *C* and *G* in Fig. 2.

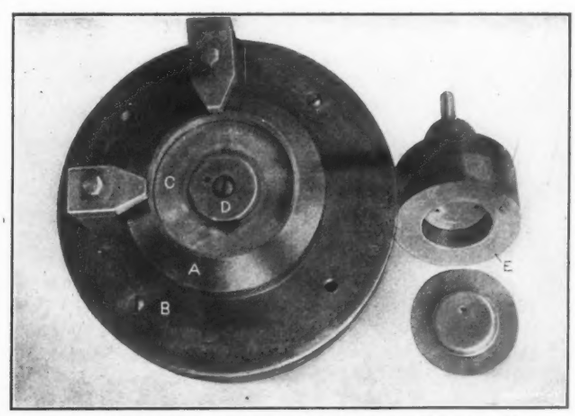


Fig. 3. Combination Blanking and Cupping Die—First Operation on Roller Bearing Cage

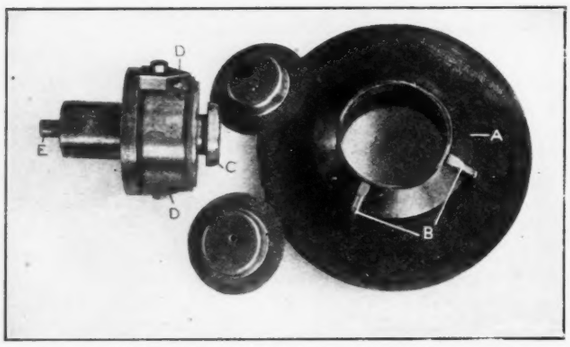


Fig. 4. Trimming Punch and Die—Second Operation on Cage

Final Drawing and Forming Operation Tools

The die and punch for performing the final drawing and forming operations on the inner and outer cages is shown in Fig. 6, and in section in Fig. 7. This punch and die not only sets the taper on the main body of the inner and outer cages, but also edges up the flange. This combination of the two operations is not generally considered good practice, but in the present case it worked out very well and has saved an extra operation, without sacrificing either speed or ease of upkeep of the tool. The pressure ring *A* operates on a rubber pressure pad located beneath the bed of the machine in the regular combination die manner. Reference to Fig. 7 will show the construction of this die more completely. *B* is the die shoe carrying the forming punch *C* that is surrounded by the pressure ring *A*, the latter being operated by a rubber pad beneath the press acting on four ½-inch by 4¾-inch spring pins. The forming part of the punch is held to the lower member of the die by the ⅝-inch screw indicated. The outer member of the forming punch *E* is a composite forging, the shank being of machine steel and the lower member of tool steel, while the inner member is a tool steel forging ma-

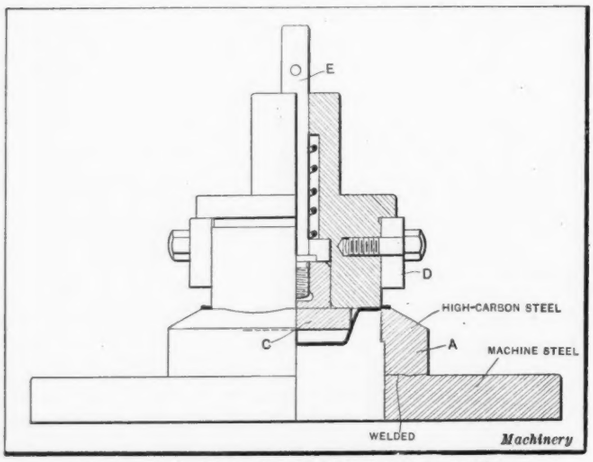


Fig. 5. Sectional Elevation of Trimming Punch and Die showing Construction

chined out to the shape of the finished pieces. Screwed to the inner forming pad *F* is a knock-out plunger *G* which is operated by a rod passing through the ram of the punch press. It will also be noticed in this case that particular attention has been given to the provision of air holes to prevent the work from being distorted and to facilitate the operation of the tools. The result of this operation on the outer and inner cages is shown at *C* in Fig. 1, and at *D* and *H* in Fig. 2.

Serrating or Piercing the Outer and Inner Cages

Following the forming of the outer and inner cages is a series of piercing operations. The first operation, which is shown at *D* in Fig. 1, is a comparatively simple one, consisting in cutting an elongated slot which acts as a locating point for the subsequent piercing operations. The die for performing the serrating or piercing operations on the inner and outer cages is shown in Fig. 8. This is of the automatic indexing type, and is of rather unique design. The center shaft *A* of this indexing fixture is on an angle with the bed of the press so as to present a horizontal surface of the work to the cutting edges of the punch. The ratchet *B* is operated through the universal joint *C* which is connected to the ram of the press.

In operation, when the press is tripped, the clutch *D* is held in engagement by means of the bar *E*, so that the punching is continuous until the required number of slots has been cut. Upon the completion of one revolution of the shaft *A*, which extends entirely through the mechanism, the pin *F* held in disk *G*, which is located on this shaft, comes in contact with the pawl *I*, tripping the bar *E* and releasing the clutch, at the same time stopping the press.

The stamping is held in place in the die by a hinged handle *J* and a latch shown at the front. Provision has been made in the interior of the die so that the plugs when punched out of the cups pass through easily. The punch, as shown at *K*, is provided with a spring stripper *L* to strip the work from the punch after the slot has been cut. The punching out of these slots is done in a press which operates at 250 revolutions per minute, or 250 strokes, and the indexing is accurate within 0.003 inch. This accuracy is necessary, not so much

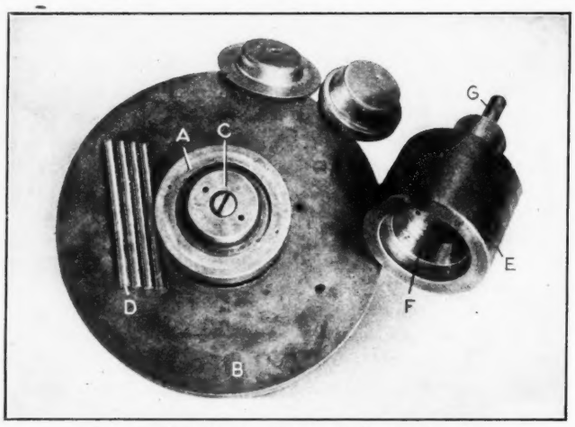


Fig. 6. Final Forming Die for Roller Bearing Cage

for the sake of the cup itself as for the fact that in the following piercing operation if the indexing is not accurate the parts trimmed out will not be cut clean and will hang on the stamping.

The next operation on the outer and inner members of the cage consists in cutting out half circles as shown at *F* in Fig. 1. These are cut out with a die of the ordinary type, all the slots being cut out at one time. The last and final opera-

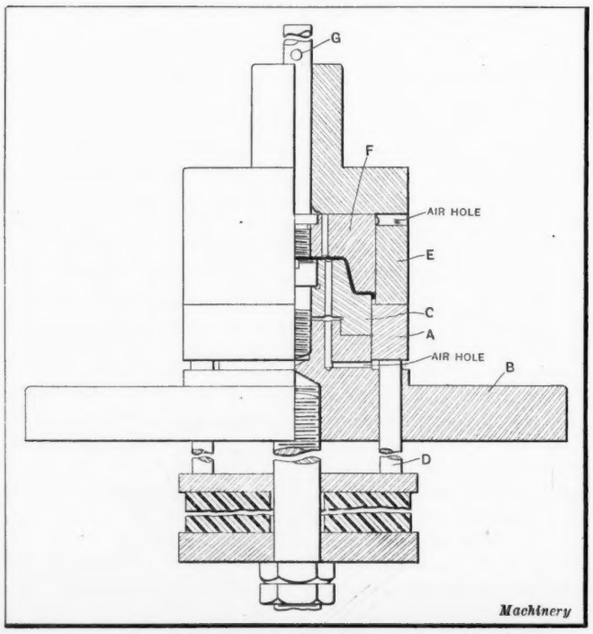


Fig. 7. Sectional Elevation of Final Drawing and Forming Die for Roller Bearing Cage

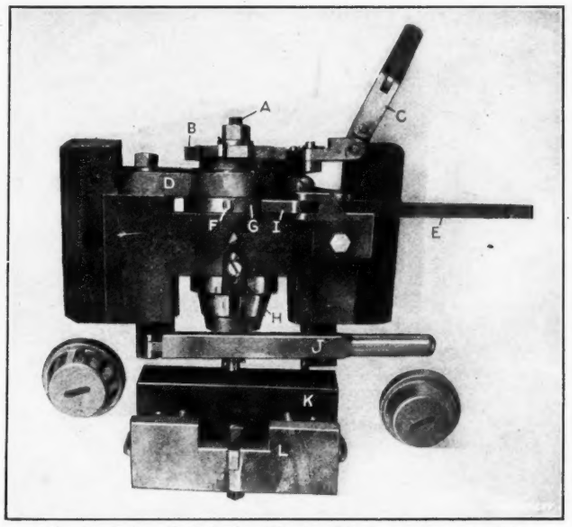


Fig. 8. Automatic Indexing Piercing Die for cutting out Slots to give Clearance for Rollers in Roller Bearing Cages

tion is the cutting out of the bottom of the cages, which is shown at *G* in Fig. 1.

After the cages have been completed, the inner cage is dropped into the outer one, the proper number of rolls are put in place, and then the top or outer part of the cage is wired down to prevent the rolls from coming out. This wiring is done by dropping the assembled cage into a recess in a block on the bolster plate of a light press and using a punch which has a recess in its face shaped exactly like the curve that it is desired to produce. The operation, of course, is very simple, and this finishes the work on the cages, which is representative of the press work turned out by the Acklin Stamping Co., Toledo, Ohio. D. T. H.

* * *

EFFICIENCY IN THE PURCHASE OF MACHINERY*

American manufacturers have long been noted for their readiness to discard workable machinery when by so doing they believed they could reduce costs or increase output. For various reasons such action has not always resulted in the expected economy, the reason being the lack of proper consideration of the requirements before buying new equipment. There are few plants to be found in which all machines are of the most suitable type. In many plants flagrant examples of hasty purchase are numerous enough, and often managers buy new machines to replace others not yet worn out, because the first machines were absolutely unfitted to the work they were called upon to perform.

Efficiency work, to many, means only the payment of a bonus to workmen or the setting of standards of production for men and equipment. The principles of efficiency, however, may be applied with even greater advantage to the purchase of new machinery, for the possibilities of obtaining the best results from any plant are largely dependent on the equipment provided. High efficiency in the purchase of equipment may best be attained by placing the selection of machinery in the hands of a committee on equipment, to consist of the works manager as chairman, the purchasing agent, superintendent, master mechanic, efficiency engineer, consulting engineer, and foreman of the department for which the machine is to be provided. Each of these men has a different point of view, and from their combined ideas the works manager will be able to decide exactly what machine will come nearest to meeting the more or less conflicting requirements and will give the desired output for the lowest unit costs.

When the choice rests with but one or two men, personal prejudices for or against certain machines gain undue power, or the first salesman to get the ear of the purchaser may sway his judgment. The purchasing agent is often ready to accept unsupported statements of the manufacturer as to performance, if the first cost is low. The superintendent would be attracted by machines which would give large outputs for low direct labor costs without great regard to first cost, probable life, or maintenance charges. On the other hand, freedom from breakdowns, cheap maintenance, and simple power requirements would especially appeal to the master mechanic. The foreman may furnish the most practical ideas of all as to what the machine will be required to do, and his personal knowledge of the previous machine will prove illuminating.

If an efficiency engineer or consulting engineer, or both, are on the staff their assistance may be of considerable value. The latter should have knowledge of machine design and leisure to work out the details required, which the other executives do not have, being responsible for costs, output, and daily supervision of the plant employes. The efficiency engineer, from his familiarity with the planning department, will know the capacity needed in the new machine to fit into the general production scheme, the speed at which it should run, the attachments required for the operative's assistance and convenience, and where it should be located to accord with present or proposed plans for receipt and delivery of materials. The diversity of opinion indicated in the foregoing shows the advantage of utilizing the knowledge of all the different heads of departments interested.

The principal points for direct consideration by the committee should be:

1. Type of machine required.
2. Proper design of type desired.
3. Capacity.
4. Class of operator and his rate of pay.
5. Operation costs—*i.e.*, power, oil, and supplies.
6. Life of machine—depreciation.
7. Price of machine.
8. Maintenance costs.
9. Adaptability to other work.
10. Cheapness of accessory tools, fixtures, etc.
11. Installation costs.
12. Floor space needed and its yearly value.
13. Safety provisions inherent in the machine or possible to supply.

The comparative costs per unit can be easily computed by adding to direct labor costs the indirect costs for power, supplies, maintenance, rent, depreciation, and interest on first cost and installation. Divide the sum by the estimated production for the period considered. If similar machines to those under consideration are in use, it will pay to see them in operation if possible. Defects may appear, and estimated capacity may be checked up with actual performance.

A further consideration which comes after the choice of the machine, and where lack of forethought may occasion serious waste, is the proper location of the equipment. We have seen parts moving through a shop in fairly direct course until a certain operation was reached. For this the parts had to be taken to the floor above and later brought back to continue through the shop. A workman may be moved from machine to machine or from one department to another, but it is costly to relocate machinery, and sometimes the cost of doing so is prohibitive. It is therefore better to plan carefully before the installation.

The location of the machine should be decided with reference to:

1. Logical points in the course of manufacture.
2. Distance material has to travel from preceding and to subsequent operations.
3. Distance power has to be transmitted.
4. Space for storage of material.
5. Lighting.

A common error is the placing of small light equipment, which requires a small amount of power and floor space, in a location suitable for heavy and powerful machinery.

Through the methods outlined above the manager of any plant may avail himself of an amount of knowledge and experience which, if utilized with systematic care, will prevent him from falling into the errors of selection which are still entirely too common. They will further enable him to choose new machines and so locate them that he will secure the desired output for the lowest unit cost at the logical point in the course of manufacture.

* From an article by E. C. Stueler and W. C. Nisbet in "Industrial Engineering."

PYROMETERS FOR SHOP USE

FUNDAMENTAL PRINCIPLES GOVERNING THE DESIGN AND CONSTRUCTION OF ELECTRICAL PYROMETERS

BY J. M. JOHNSON*

WITHIN the last few years, the importance of the pyrometer has greatly increased owing to its extensive application in the heat-treatment of steel, and also to the general recognition of the fact that a more uniform product can be turned out by less highly skilled men using accurate instruments than by men of the widest experience in the heat-treatment of steel who determine temperatures by the "color" method. Furthermore, pyrometers are the means of saving expense due to loss of work through overheating, and the consumption of an unnecessary amount of fuel to obtain a desired result. In several commonly used types of pyrometers, the accuracy of the results obtained with the instruments are dependent upon the way in which they are used. But as many foremen and others engaged in the heat-treatment of steel often know relatively little of the underlying principles upon which the instruments that they use operate, such men fail to obtain the degree of accuracy of which the pyrometers are capable. As a result, the instruments are blamed where the real cause of complaint is attributable to the ignorance of the workman. Realizing the importance of this condition, it is felt that the following article describing the fundamental principles of the design and use of pyrometers will be of value to many readers of MACHINERY.

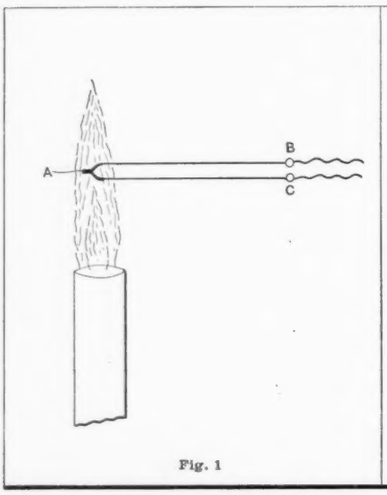


Fig. 1

Fig. 1. Diagram illustrating Principle of Thermo-electric Couple

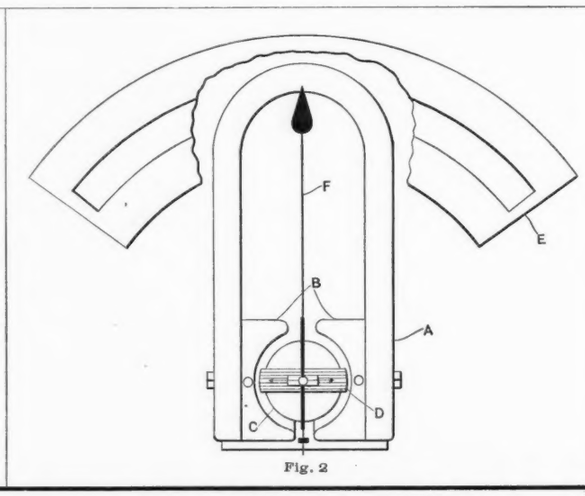


Fig. 2

Fig. 2. Principal Parts of a Typical Form of Millivolt Meter

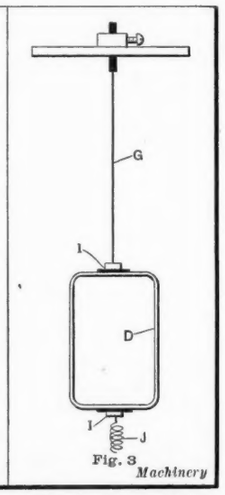


Fig. 3 *Machinery*

Fig. 3. Coil of Suspension Type of Pyrometer

A Brief History of Pyrometers

By pyrometer we mean an instrument used to measure temperatures over 500 degrees F. Perhaps the first instruments made use of as pyrometers (if they may be called such) were the Seiger cones which were made from clay and placed in a furnace whose temperature was to be ascertained. These cones would soften and bend over when the temperature for which they were calibrated was attained. They, of course, were of little use, as they did not show whether the temperature was rising or falling, and when once used were rendered useless. Another early form of pyrometer, now used to some extent (the copper bomb) consists of a vessel of water with a low range thermometer in it. A copper ball of known weight is placed in the furnace whose temperature is to be measured, and after leaving the copper ball in the furnace long enough to acquire the same temperature as the furnace, it is quickly transferred into the vessel of water. The increase in the temperature of the water is noted, and by reference to the table supplied by the maker of the pyrometer, the temperature of the furnace is obtained. Other types of heat gages could be mentioned, but very few of them are practical enough for the measurement of high temperatures to be worthy of mention. The only really practical instrument yet devised is the one to be described, which operates on the thermo-electric principle.

Different Thermo-couples and the Fundamental Principles of the Thermo-couple

When two dissimilar metals are held in contact and the point of contact is heated, a small current of electricity is generated, and in most cases the magnitude of this current is proportionate to the intensity of the temperature. As an example, when an iron and a copper wire are twisted together and welded and the junction *A*, Fig. 1, is heated, a current of electricity is generated due to the difference of temperature between the hot junction *A* and the cold junctions *B* and *C*. The greater this difference in temperature between *A*, *B* and *C*, the greater the voltage generated. Any two unlike metals when twisted together and welded will generate an electromotive force when heated, but they may not be suitable for the couple of a pyrometer: first, because some combinations of metals do not give as high an electromotive force as other couples; and second, because some metals do not have a melting point that is high enough to make them useful. The requirements of a good thermo-couple are: first, a high melting point of the elements; second, the ability to generate as large an electromotive force as possible, and an electromotive force which will increase as nearly as possible in direct proportion to rise in temperature in order to obtain a uniform scale; and third, constancy of couples throughout their life.

To meet all these requirements we find that our choice of metals is cut down to a comparatively small number. Platinum and platinum rhodium is a thermo-couple largely used. One wire is pure platinum and the other platinum alloyed with 10 per cent of rhodium. This couple is what is known as the Le Chatelier couple, and is considered a standard when received with a certificate giving the millivolts corresponding to degrees of temperature. This certificate is issued by the maker and can, for a small fee, be certified by the Bureau of Standards at Washington, D. C. The objection to this couple for everyday shop use is its high cost and the small electromotive force generated, which amounts to only 17 millivolts (0.017 volt) when the junction *A*, Fig. 1, is heated to 3000 degrees F. and the ends *B* and *C* are at 32 degrees F. This couple, in common with other couples, absorbs gases rapidly and becomes very brittle, causing it to break easily after some months of use, if it is not properly protected. The electrical resistance of the couple is also very high, and being nearly a pure metal couple its tem-

* Address: 1 New St., Naugatuck, Conn.

perature coefficient is very high, which is an objection in shop use, as will be explained later; although in the laboratory it is undoubtedly the recognized standard where the proper conditions can be had for its use.

The Instrument or Millivolt Meter

This is the name given to the instrument which measures the small voltage generated by the thermo-couple, and which is calibrated to read in degrees F. or C., as the case may be. As before stated, the voltage generated by the thermo-couples, even with the strong base metal couples, is only a few thousandths volt, so that a very sensitive instrument is required to record it. There are two distinct types of millivolt meter movements in use, *i.e.*, the "suspension type" and the "pivoted type," and as regards their electrical construction they are quite similar, differing only in their method of supporting the moving element carrying the pointer. Both types have five distinct parts, namely, the magnet, moving coil, pointer, scale and control springs (or suspension). The magnet is generally of U-shaped design, as shown at *A* in Fig. 2, and has two pole pieces *B* fastened to its ends. The pole pieces are accurately bored out, and a round core *C* is supported in this space. The core is somewhat smaller than the opening of the pole pieces, thereby leaving an annular opening in which the coil *D* moves. The purpose of the core *C* is to shorten the path for the magnetic lines of force, rendering the instrument more sensitive and aiding in keeping the strength of the magnet constant.

Fig. 3 shows the moving coil and suspension *G*. The coil generally consists of an aluminum frame, wound with copper wire, the frame serving the double purpose of supporting the wire and suspension sockets *I*, and also renders the instrument "dead beat," due to the Foucault currents generated in it. The suspension type of movement is the only movement that is practical for use with a platinum couple, because it is possible to make this type of movement very sensitive to small voltages, which is necessary with this couple. The disadvantage of the suspension type of instrument for shop use is that it must rest on a very solid foundation and it is not a portable instrument in the true sense. It must be accurately leveled up before using, and it is quite fragile due to the thinness of the suspension. It also has a rather long damping period, *i.e.*, when using it with a number of couples by means of switches, it takes an appreciable time for the pointer to become steady to indicate the correct temperature. As a laboratory instrument, however, and for very accurate checking purposes, when properly handled, it is a very satisfactory instrument. Fig. 4 shows the most common method of securing the suspension *G* and lower lead spring *J*; this spring exerts no torque on the moving coil, but merely serves to lead in the current. The top suspension, in which the coil hangs, acts as control and lead-in for the current.

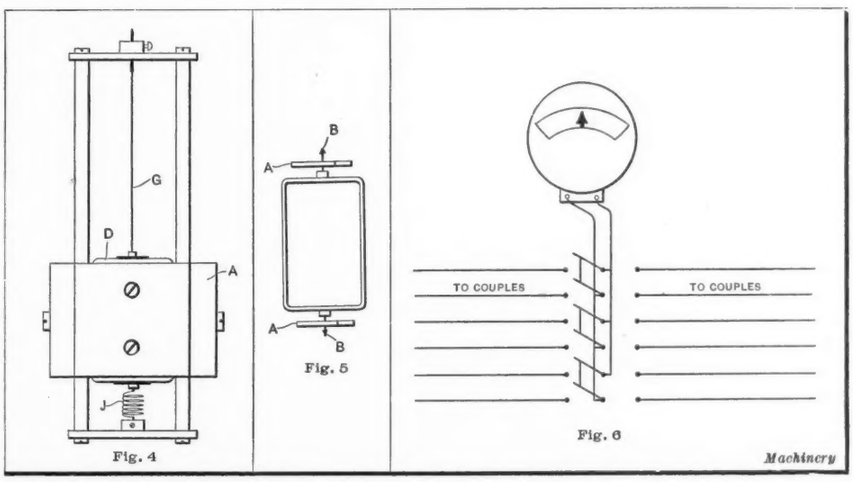


Fig. 4. Method of securing Suspension G and Spring J

Fig. 5. Coil of Pivoted Type of Pyrometer

Fig. 6. Diagram showing Arrangement of Double Pole Switches used to connect Several Couples with one Instrument

The pivoted instrument, as the name implies, has the coil supported in jewel bearings instead of on the suspension. The current is led into the moving coil by means of two flat spirally wound phosphor-bronze springs shown at *A* in Fig. 5, which serve as the control and also for leading the current into the moving coil of the instrument. The pivots *B* are of hardened steel and rest on sapphire jewels. This type of movement is generally the one adopted for shop pyrometers on account of its ruggedness and quickness in coming to rest. After connecting to any one of several couples it can be located in any position and needs no leveling. The pivoted type instrument is, however, only practical in connection with the base metal couples (base metal couple meaning couples that are not platinum) on account of the greater voltage generated by the base metal couples giving more power. At this point it may be well to mention that suspension instruments are termed high-resistance instruments, while pivoted instruments are termed low-resistance instruments. Suspension instruments generally have an internal resistance anywhere from 200 to 1000 ohms, while the pivoted instrument has a resistance of only from 5 to 15 ohms. The effect of this difference in resistance will be discussed under the following heading.

Leads and Switching Devices

By leads is meant the wires that carry the current from the thermo-couple to the instrument. In all cases the length of lead that is supplied by the maker should never be cut or lengthened, except when used with the suspension type of instrument where the resistance is equal to 500 or 600 ohms as stamped on the scale of the instrument. In the case of an instrument having 500 or 600 ohms resistance, the addition of 200 or 300 feet of wire will not introduce any appreciable error. As an example, suppose we have a suspension instrument and that on its scale or on the certificate sent with it, it is stated that the instrument has a resistance of 500 ohms; and that the leads that were supplied are not long enough to reach to some solid foundation. We could safely add 200 feet of No. 14 B. & S. gage copper wire, because this wire has a resistance of only 0.005 ohm per foot double, which for 200 feet would be $200 \times 0.005 = 1$ ohm. This introduces an error in the reading of the pyrometer of only 0.2 per cent, which at 1500 degrees F. would mean that the instrument reads low by 3 degrees F., and for shop use this would be a negligible error. On the other hand, with a low-resistance pivoted type of instrument having only 10 ohms resistance, if we should add 200 feet of No. 14 B. & S. copper wire having 1 ohm resistance, we would have an error of 10 per cent. At 1500 degrees F., that would equal an error of 150 degrees that the instrument would read low.

The above examples also hold for the length of thermo-couples used on the suspension instrument. It does not matter much whether the thermo-couple is shorter or longer than originally supplied with the instrument, but with a low-resistance instrument it is important that the thermo-couple be kept within 12 inches of the original length as supplied by the maker, for the reasons stated. In some makes of instruments called high-resistance, it is found that they have an internal resistance of only 100 ohms, or even less. It is, of course, evident that shortening or lengthening the leads will cause an appreciable error with an instrument of this class. Also, on an instrument having about 100 ohms resistance and using a platinum couple, it is important to expose the same length of couple to the heat at all times on account of the temperature coefficient of the couple before mentioned. Platinum, in common with all pure metals, changes its re-

sistance with change of temperature, the change equaling approximately 0.002 ohm per degree per ohm, or it about doubles its resistance for every 500 degrees F. rise in temperature. To illustrate how this may affect the accuracy of a so-called high-resistance instrument, the actual resistance of which is only 100 ohms, consider an instrument with 24 inches of couple exposed to the heat in the furnace, 12 inches of the platinum couple having a resistance of 0.5 ohm at room temperature. At 1500 degrees F. this resistance is increased to $1500 \times 0.002 \times 0.5 = 1.5$ ohm. The instrument will read 1.5 per cent low at this temperature if its scale has been drawn, taking into account the heating of 12 inches of the couple. The base metal couple is practically a zero coefficient; therefore it can be heated any length.

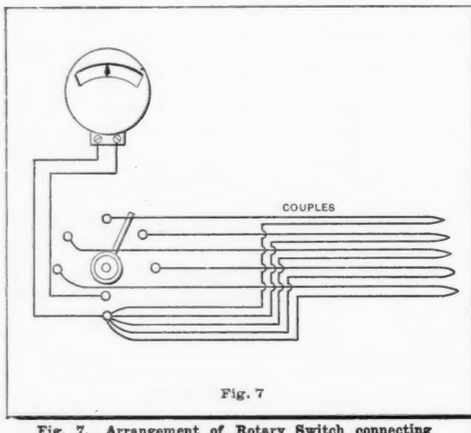


Fig. 7

Fig. 7. Arrangement of Rotary Switch connecting Several Couples with one Instrument

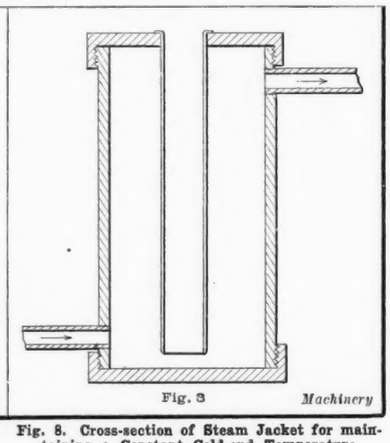


Fig. 8

Machinery

Fig. 8. Cross-section of Steam Jacket for maintaining a Constant Cold-end Temperature

Switching Devices

Several thermo-couples are often used with one instrument; therefore, some switching device must be used, which in most cases consists of a double pole switch or a rotary switch. Connections to double pole switches are made as shown in Fig. 6, while connection to a rotary switch is made as illustrated in Fig. 7. Switches should be kept clean and bright, and this is especially important on low-resistance systems. Where a furnace is so large that two or more thermo-couples are required, the double pole switch gives the best results on account of the fact that the rotary switch has one common point of connection to all thermo-couples and it is almost impossible to thoroughly insulate the thermo-couples, stray currents between the thermo-couples themselves being liable to cause a considerable error. The rotary switch is, however, more desirable than the double pole switch where two or more furnaces each having one thermo-couple are indicating on one instrument, as it is possible to take readings faster and it shows at a glance which furnace is switched onto the instrument.

The Cold End of the Couple

The cold end is the name given to the points where the couple ends and the conducting wires are soldered on, *B* and *C* being the cold end of the couple shown in Fig. 1. The instrument, as already mentioned, measures in millivolts (0.001 volt) and its scale has been marked to indicate directly in degrees of temperature. The number of millivolts obtained from the couple depend upon the difference of the temperature between the junction *A*, Fig. 1, and the cold end *B–C*. For example, suppose the junction *A* is at a temperature of 1500 degrees F. and the cold end *B–C* has a room temperature of 75 degrees F. The difference is 1425 degrees, and assuming that we get 50 millivolts for this difference, where the 50 millivolt point should come on the scale we find marked 1500 degrees F., which is the correct temperature of the furnace, providing the instrument has been calibrated for a cold end temperature of 75 degrees. When the wire is disconnected from the instrument, the pointer should stand at 75 degrees, which is at the beginning of the scale. Should we now raise the temperature of the cold end to 100 degrees F., our difference between the hot end and cold end which was 1425 degrees is now only 1400 degrees, and the number of millivolts generated is less in direct proportion, causing the instrument to read only 1475 degrees F., while the furnace is still at 1500 degrees, thus giving an error of 25 degrees that the instrument reads low. To conclusively demonstrate the correctness of the preceding explanation: should we heat the hot junction *A* and the cold end *B–C* to the same temperature we would get no indication on the instrument, because the temperature difference would be zero, which gives us no generated millivolts.

The high-resistance platinum couple instrument, known as the "Le Chatelier" pyrometer, is as a rule calibrated for a cold end temperature of 32 degrees F., which is the temperature of melting ice. It can be readily seen by observing the scale of an instrument, at what point the cold end is to be kept. In the case of the high-resistance instrument just mentioned, the pointer comes to rest at 32 degrees, which is generally marked in small figures on the scale. In using this instrument for obtaining actual indications of temperature, it is necessary to provide a vessel containing a little water and chopped ice, and immerse the cold end in the ice water. The commercial shop instrument, or the low-resistance type, is generally calibrated for a cold end temperature of 75 degrees F., it being assumed that 75 degrees is a fair average temperature in a shop; but in many cases it is found impracticable to go far enough away from the furnace with the cold end to obtain a uniform temperature of 75 degrees. Therefore, some means of keeping the cold end temperature constant is desirable. Many schemes for doing this have been tried, such as the use of water jackets and burying the cold end in the ground, which of course is all right if one is certain that the temperature does not vary greatly; but one of the surest ways of taking care of the cold end is to place it in boiling water, which can be done by using a chamber made from a pipe having a cap screwed on the top and bottom, and a copper well closed at one end extending down into this pipe. The outside pipe, as shown in Fig. 8, should have a small inlet and an outlet. Steam can now be connected to the lower pipe, which will condense inside of the chamber, and very little of the steam will escape through the top pipe, thus maintaining a uniform cold end temperature of 212 degrees F. Now, to adjust the instrument to correspond to this cold end temperature, all we have to do is to set the pointer at 212 degrees on the scale when the leads are disconnected. This is accomplished by a zero adjuster that is found on most instruments. If the instrument is not provided with a zero adjuster, the cover may be taken off, and on the movement there will be found a cross piece shown at *A* in Fig. 9, having a clip *B* on it to which the spring *A*, Fig. 5, is soldered. Holding this clip are one or two little screws shown at *C* in Fig. 9. To adjust the pointer to 212, loosen the two screws *C* and move clip *B* until the pointer stands at 212 degrees F. Of course while doing this the leads to the instrument should be disconnected. If we now insert the cold end into the steam jacket, when steam is going through, the instrument will be correct as far as the cold end temperature is concerned, and will stay correct as long as the steam is flowing through the steam jacket.

Methods of locating the Thermo-couple in a Furnace and how it should be Protected

The base metal couple—the one that is best adapted for shop use—is generally made up of two wires having a diameter of about ⅛ inch, so that the couple is quite rugged. It is generally insulated by winding each one of the wires with asbestos thread and afterward painting it with some cement composed of alundum, or carborundum and silicate of soda. The couple, insulated as described, is then placed in a ⅜-inch iron pipe, which is supposed to go into the furnace. In most cases, however, and especially in the case of pyrometers used in high-temperature annealing furnaces,

it is desirable to put one more thickness of pipe over the ⅜-inch pipe, as it gives a longer life to the thermo-couple; and when the temperature does not change very rapidly the couple is found to be sensitive enough. The couple should be mounted in the furnace either from the top or from the side, and it should not be near the source of heat, but should be placed in such a position that it receives the average heat. The thermo-couple should project into the furnace at least 6 inches, and if possible 10 inches, because there is a great amount of conduction along the pipes that form the protection of the couple, which would tend to make the temperatures indicated by the pyrometer too low, if the thermo-couple was not inserted in the furnace for at least this distance. After the thermo-couple has been used for some time, it should be examined to see if the wires are broken or bare of insulation. If the wires are broken close to the twisted and welded end, the couple may be cut off and scraped clean for an inch or two, twisted together again and welded by means of the oxy-acetylene flame, or electric arc. Of course before welding the couple—should it be bare of insulation—it should be first wound with asbestos, as it will be found more convenient to wind the wires when they are apart than when they are welded together. Platinum couples may be welded very successfully in the electric arc, and in this way the life of the thermo-couple can be considerably lengthened, because as a rule the loss of 12 or 14 inches of the couple will not introduce any appreciable error.

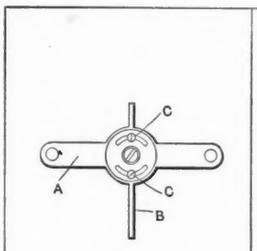


Fig. 9

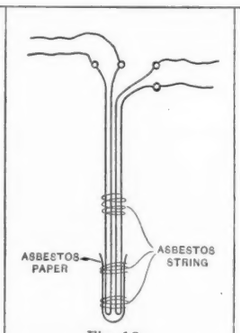


Fig. 10

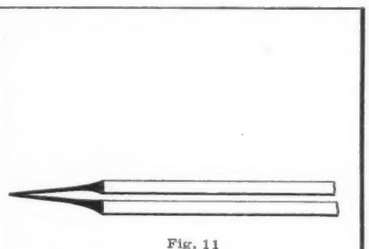


Fig. 11

Machinery

Fig. 9. Adjustment on Movement for setting for Proper Cold-end Temperature

Fig. 10. Method of checking "Shop Couple" against "Standard Couple"

Fig. 11. Diagram showing Modification of Pyrometer Couple for obtaining Recalescence Point of Steel

Methods of Checking a Pyrometer in the Shop

A pyrometer, like any other instrument, must be frequently checked. In order to do this easily and with a fair degree of accuracy, it is desirable to have on hand one portable instrument that is used only for checking purposes. If such an instrument is at hand, the easiest way to check the shop pyrometer is to take the thermo-couple of the standard instrument and remove it from its pipe protection. Likewise with the pyrometer that is to be checked: remove its couple and protection from the furnace and remove the protection from the thermo-couple, and tie the standard couple and the couple that is to be tested together with asbestos thread, first insulating each with a small piece of asbestos paper at the tip. Fig. 10 shows the method of tying the couples together and protecting with asbestos paper. A small cast-iron pot or crucible with commercial lead can be used as the source of heat. The lead can be heated to a temperature of 1500 or 1600 degrees F., and the couples, having very little protection on them, are immersed in the lead but not allowed to touch the bottom of the pot. Under these conditions, the couples will very rapidly acquire the temperature of the molten lead; also being of the same cross-section, they will follow each other with a very slight temperature difference between the two. By observing the shop instrument on the test and the standard instrument, the difference in reading may be easily noted, which should be marked down in tabulated form for three points on the scale; and these records should be kept, as they show a history of the instrument, *i.e.*, whether its error, if any, is constant or varies.

If the pyrometer installation is a small one and it would be too expensive to keep an instrument only for the purpose of checking, tests are made by using known melting points. Two points on the scale may be easily checked, as every metal when it solidifies keeps its temperature constant for an appreciable length of time—long enough so that one can easily determine the melting point by observing the pyrometer pointer. For instance, lead solidifies at 618 degrees F., which forms our first checking point. Common table salt, or sodium chloride, solidifies at 1440 degrees F., approximately, and gives a fine high point for checking. Of course it is understood that the couple should be insulated with asbestos paper, as previously mentioned, and immersed directly into the lead, or salt, as the case may be. More refined methods could be mentioned, but it is impossible to make use of them outside of the laboratory with any degree of accuracy.

General Points to Observe in the Use of the Pyrometer

The most common sources of error with pyrometers are, as a rule, found to be due to variations in the cold end temperature or to dirty contacts at the switches or binding posts, and special attention should be given to these three points to insure good results. Another common source of trouble is that the indicating instrument is hung up on the furnace where the temperature of the instrument sometimes is as high as 150 degrees F., which is too hot for an electrical instrument; and no great accuracy can be expected under this condition. The moving copper coil of the instrument has a high temperature coefficient and its resistance changes appreciably with change of temperature, it being negligible for a few degrees, but rises of 50 or 75 degrees above room temperature—for which the instrument was calibrated—will cause a serious error. Also the phosphor-bronze control springs will fatigue when exposed to this high temperature, tending to make the instrument read low.

How to Obtain the Recalescence Point of Steel

It is often desirable to find the recalescence point of steel. This can be done with a commercial indicating or recording pyrometer with a very slight modification of the thermo-couple, by taking the thermo-couple and reducing the tip of the junction, Fig. 11, for a length of about 1½ inch. Reducing it to a diameter of about 1/16 inch, winding it with asbestos and again rewelding the ends, will render the thermo-couple very sensitive to rapidly changing temperatures. A small sample of the steel of which the recalescence point is to be taken, has to have a hole drilled in it about 1 inch deep and large enough to take the reduced end of the couple. The thermo-couple is then inserted into the steel sample, and the sample is heated either in a small electric furnace or uniformly heated with a gas flame until the pyrometer shows a temperature of about 1700 degrees F. Without disturbing the couple, the sample and couple are removed from the fire and the sample allowed to cool. Readings on the pyrometer are now taken every 10 seconds, putting the readings down in one column for time and in another for temperature. The temperature as indicated by the pyrometer will be less for every 10-second reading, until the recalescence point occurs, when the temperature will remain constant for 20 or 30 seconds, and sometimes as long as 1 minute, depending on the size of the sample. This steady point is, of course, the recalescence point of the steel. If the absorption point is wanted, the temperature and time are taken every 10 seconds while heating the sample, although the absorption point will not stay steady as long on the pyrometer as the recalescence point. Of course if a recording instrument is at hand, simply by reducing the diameter of the couple as previously described, the recorder will record the absorption and recalescence points. If the sample is made ½ inch in diameter and 2 inches long, it is amply big for obtaining these points. The hole should not be too large, but the thermo-couple should fit rather snugly in it.

MAKING SECTIONAL MOLDS FOR DIE-CAST NAMEPLATES

METHOD OF ASSEMBLING THE SAME MOLD SECTIONS IN VARIOUS COMBINATIONS

BY EDWARD K. HAMMOND*

THE method of manufacturing nameplates for machinery developed by the Federal Nameplate & Novelty Co., 732 Federal St., Chicago, has two noteworthy advantages. Of primary importance is the fact that the letters, numbers and decorations are made to stand out in bold relief, so that the nameplate possesses the maximum publicity value and will not become worn smooth and illegible during the life of the machine to which it is attached. The nameplates are die-cast, and by means of a patented method by which the molds are made, each letter, figure, or unit of decoration or background is contained in a separate block of steel. These blocks are carefully ground on all sides so that they fit accurately together, and can be locked up in a frame to form the mold matrix. Then after the required number of nameplates has been cast, the mold is broken up and the sections distributed to the different "fonts" or cases in which they are kept. As the same mold sections can be used over and over again in casting nameplates requiring any combination of letters, figures and decoration, they constitute a stock in trade for the nameplate manufacturer, and as a result the purchaser only has to pay for the actual plates which he receives, no charge being made for making the letters, numbers or background sections of any size required to fill an order, if they are not in stock at the time the order is received.

Fig. 1. Examples of Federal Nameplates, showing Variety of Letters, Numbers, Backgrounds, Decorations and Borders that can be employed

It is the purpose of this article to describe the method of making the mold sections and the manner in which these sections are combined to form the complete mold for casting any given nameplate. For the purpose of description, it will be assumed that an order is received which requires different mold sections from those already in stock. Such being the case, it would be necessary to make up these sections before proceeding to fill the order; but if they are standard letters, numbers, etc., which there is a reasonable chance of using over again, no charge would be made for this part of the work. The method of procedure is as follows: A master punch or "hub" is first made for each letter or figure in the required nameplate, and after these have been completed the mold sections are produced by forcing the master punches into the ends of accurately finished steel blocks by means of hydraulic pressure. The tool steel blocks from which the mold sections are made are finished to approximately the required size before the impressions are made in them, and after this operation has been performed, all sides of the blocks are accurately ground to size so that they will fit together properly. After this work has been done the mold sections are locked up in a frame, as shown in Fig. 2, which is closed in by a plain plate at the back, this plate being at the proper distance from the faces of the mold sections to give the required thickness to the nameplate. The mold is then ready to be sent to the die-casting room, where it is set up in the machine ready for casting the required number of nameplates. Having made this preliminary statement, we can proceed with a detailed description of the different operations involved in making the mold.

Engraving the Hubs or Master Punches

In making the hubs or master punches, the first step is to prepare the tool steel blanks; and for the purpose of reference, a drawing has been made of the master punch for the letter Z as shown in Fig. 4. The blank is first accurately ground so that the sides *A* and *B* are exactly at right angles to each other, these sides being used for the purpose of locating the blank in the different fixtures in which it is held while engraving. After the sides have been ground in this way, the face of the blank in which the letter is to be engraved is first ground perfectly smooth and square with the sides *A* and *B*, after which it is polished on a lapping plate charged with flour of emery so that a very smooth surface is obtained on which the letter is laid out.

In laying out the work there are two alternatives: The engraver may be called upon to reproduce a master punch which has been damaged, or he may be required to lay out a new letter or letters of a specified size; and the method of procedure will be different in these two cases. The method of reproducing a master punch which has been damaged is as follows: The block which has been finished according to the preceding description is clamped in one socket of the double jointer which is shown at *A* in Fig. 5, and the block on which the letter is to be laid out is secured in the other socket of this tool. The double jointer is merely a duplex clamp which provides for holding the work and the master which it is desired to reproduce. The socket in which the work is held may be adjusted by means of two screws, one of which regulates its lateral position and the other its angular position, so that the block is lined up with the master that is being worked from. After these adjustments have been made, the engraver uses his square *B*, angle gage *C*, etc., to locate the required points on the work from the master which is held in the other socket of the double jointer. When these points have been located, the letter is laid out and the work is then ready to be engraved.

For this purpose, a special routing machine is used, which is shown at the right-hand side of Fig. 3. The head of this machine is provided with the usual form of micrometer stop for regulating the depth to which the work is engraved, and the vise is provided with a special form of micrometer collar for locating the work for engraving along angular lines, such as the cross bar of the letter Z. For making this setting, the engraver will use his micrometer gage to measure the distance *C* on the master shown in Fig. 4, from which he is working; or on the letter which he has laid out on the work, should he be laying out a letter from dimensions. He will

* Associate Editor of MACHINERY.

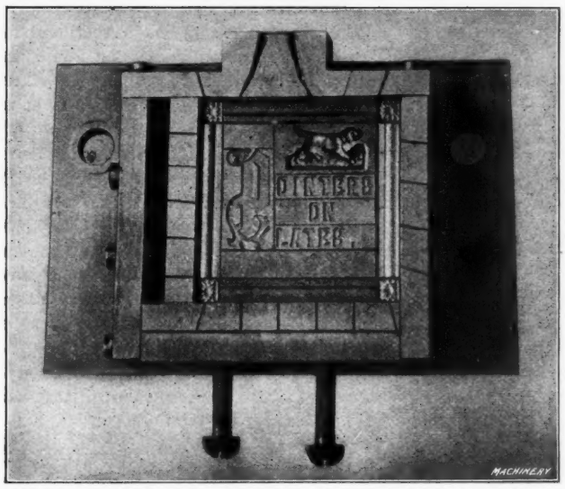


Fig. 2. Assembled Mold with Back Plate removed to show Matrix

then swivel the vise on the engraving machine through a corresponding distance. This results in bringing the cross bar on the letter parallel with the cross-slide on the engraving machine, and it is then an easy matter to run the routing tool along the required lines.

Testing the Accuracy of the Engraved Punches

After the routing operation has been completed, the engraving of the master punch or hub is finished by means of the hand gravers shown at *D* in Fig. 5, and as the engraver uses a watchmaker's glass, he is able to attain an extremely high degree of accuracy. When the engraving has been finished in this manner, it is necessary to prove the accuracy of the work, the tests consisting of measuring the "weight" or thickness of the lines, the depth to which the letter has been engraved, and the size of the letter. For measuring the thickness of the lines, "ceriph" gages are employed, which are shown at *E* in Fig. 5. These gages consist of two semi-cylindrical members which are sharply pointed at the ends. The two parts of the gage are pinned together in such a way that the two halves may be moved longitudinally in relation to each other. In using the ceriph gage, the engraver first sets it so that the two points lie on opposite sides of the line on the master letter, which is to be compared with the line on the letter that has been engraved. This setting can be made with extreme accuracy, as the points are quite sharp and the watchmaker's glass magnifies an error in setting which would be invisible to the naked eye. After the ceriph gage has been set from the master punch, it is used to measure the accuracy of the corresponding line on the work. All of the lines are gone over in this way and any errors are corrected.

The next step consists in measuring the accuracy of the "counter" of the letter, the micrometer counter-gage shown at *F* in Fig. 5 being used for this purpose. In this connection it will not be out of place to explain that the "counter"

Fig. 3. Engraver's Bench, with Special Routing Machine at Right and Vise Stand at Left

of a letter is its inside width, the counter of the letter Z being the distance indicated by *D* in Fig. 4. It will be seen that the micrometer counter gage is a special micrometer caliper made with parallel knife-edges which are accurately set on the opposite sides of the "counter" by the aid of the watchmaker's glass. After the accuracy of the counter of the letter has been determined, a lining gage is employed to determine the accuracy of the positions of the "cap" line, the "descender" line and the "side" or "set" line of the letter. The lining gage is shown at *G* in Fig. 5, and it will be seen that this tool is provided with three knife-edge blades which may be set independently of each other for determining the three dimensions of the letter that have been referred to. A shoulder on the lining gage bears against the finished sides of the jointer in which the work is held. In working from a master letter, micrometer collars on the tool are not necessary, as the working edges of the three blades are brought into coincidence with the corresponding lines on the master, these positions being determined with the aid of the watchmaker's glass. After the settings of the gage have been made, the tool is used in proving the accuracy of the punch which has just been engraved. But where the engraver is working from specified dimensions instead of a sample letter, the micrometer lining gage shown at *H* is used to check up the "cap," "descender" and "set" lines.

In this connection, it may be mentioned that the "cap" line is the bottom line of the capital letter or the line on which all of the letters rest. The "descender" line is the line marking the distance which the lower case letters g, j, p, q and y extend below the "cap" line. The "side" or "set" line is the distance of the right-hand side of the letter from the side *B*, Fig. 4, of the block on which it is engraved. The accuracy of this dimension is a point of vital importance, as all letters are located on their blocks from the side *B*, and the proper spacing of the letters is determined in this way. All of the required dimensions have now been determined with the exception of the depth to which the letter has been engraved, and for this purpose the depth gage shown at *J* in Fig. 5 is employed. This is simply a refinement of the machinists' depth gage, and is used in about the same way, except that there is a sharp knife-edge which comes into contact with the finished face of the work, and accuracy is proved by noting whether the knife-edge is raised sufficiently from the work to permit light to pass underneath it.

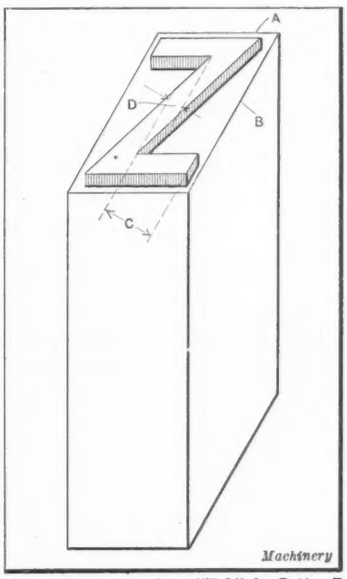


Fig. 4. Master Punch or "Hub" for Letter Z

The preceding description applies to the laying out of a master punch or hub from an existing master punch. When it is required to lay out a letter without the use of a master, the location of each point must be determined by the micrometer screws on the engraver's gages. The required size of the letter and weight of the lines will also be determined with these micrometer gages, and after the letter has been engraved its accuracy will be proved as described in the preceding paragraph, except that the gages will be set by means of the micrometer screws instead of setting the edges of the gages to the required faces on the master from which the work was laid out.

Making the Mold Sections

After the accuracy of the engraving operation has been proved in this manner, the punch is transferred to the hardening department where the steel is hardened in accordance

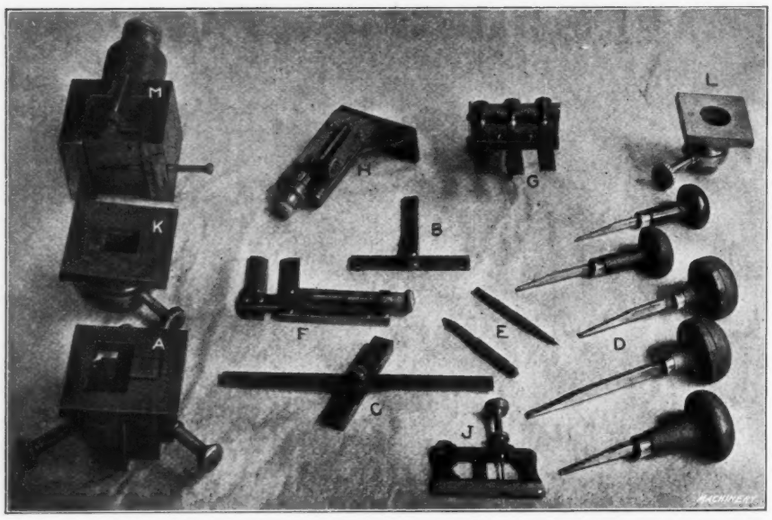


Fig. 5. A, Double Jointer; B, Square; C, Angle Gage; D, Gravers; E, Ceriph Gages; F, Micrometer Counter Gage; G, Lining Gage; H, Micrometer Lining Gage; J, Depth Gage; K and L, Single Jointers; M, Bevel Jointer used to get Uniform Bevel on Hubs

with the standard practice followed in the heat-treatment of tool steel; and after this has been done, the punch is ready for use in making the mold sections. In making the mold sections, commercial annealed tool steel is used, from which blanks of the required size are machined up and ground to the approximate size. These blanks are then mounted in the fixture shown in Fig. 8, which is carried on the bed of a hydraulic press that is used to drive the hub down into the face of the blank to produce the required impression for the mold section. Reference to Fig. 8 will show that this fixture is provided with two slides *A* and *B* which enable the longitudinal and transverse adjustments to be made, in order to locate the work in the proper position under the punch. The longitudinal movement of the fixture obtained by the slide *A* is regulated by the screws *C*, while the transverse movement

Fig. 6. Set of "Hubs" or Master Punches for Large Letters

of the slide *B* is governed by a pair of screws carried by a plate secured to the bed of the press.

In addition to the means of making these adjustments, it will be seen that the fixture is provided with two backing-up screws *D* which hold hardened steel plates *E* against two sides of the work, and force the work against the two fixed sides of the socket in the fixture. In this way the blank is adequately supported on all sides so that it will not be distorted by the high pressure which is necessary to drive the punch down into the steel. But to guard against slight distortions which may occur, the blanks are transferred from the press to a Brown & Sharpe No. 2 surface grinder, where they are held on a Walker magnetic chuck and ground on all sides to reduce them to exactly the required size, and at the same time to eliminate any slight errors which might result from distortion during the formation of the depression under the hydraulic press. In this grinding operation, care must be taken to have the sides of the blank ground exactly parallel and to have all blanks of exactly the same size; otherwise, the different sections required for a finished mold would not fit together properly. Also, it is obviously necessary to have all of the mold sections of exactly the same height in order that they may be assembled with their working surfaces exactly level.

Assembling Finished Sections into Mold

After the necessary mold sections have been made, they are assembled and locked together to produce a mold of the general form shown in Fig. 2. The mold is shown with the back plate removed to show the matrix; but this plate is merely a flat piece of steel which fits closely against the rim and forms the plain back of the nameplate. It will be seen that the rim at the top of the mold is gated to provide the necessary space for the metal to flow into the mold. There is nothing of exceptional interest about the die-casting operation, and as the subject of die-casting has been quite thoroughly treated in articles published in MACHINERY, further treatment of this work is unnecessary.

The Distinctive Features of Federal Nameplates

It has been the purpose of this article to describe the method and operations involved in making sectional molds for die-casting the nameplates made by the Federal Nameplate & Novelty Co.; but as the means by which any desired end is attained is merely incidental to that end, this article would be incomplete without making some detailed reference to the class of work produced in the molds. The fea-

Fig. 7. "Hubs" for Small Letters, Figures, Backgrounds, Borders, Decorations, etc.

tures of obtaining nameplates with the lettering and design in bold relief, and the possibility of obtaining these plates without the expense incident to engraving a special mold matrix for each different plate have already been referred to. This process of die-casting machinery nameplates is also well suited for application in the production of speed and feed plates for machine tools, door plates, and various other classes of work where letters, numbers and decorative effects are required in various combinations.

The plates are made from two classes of metal, depending on whether they are to be mounted on a flat surface or a curved surface. In cases where the finished plate is required to be bent to fit over a curved surface, white metal is used, as this metal is quite flexible and can be bent without danger of breaking. But where the finished plate is to be mounted on a flat surface, greater durability is obtained by

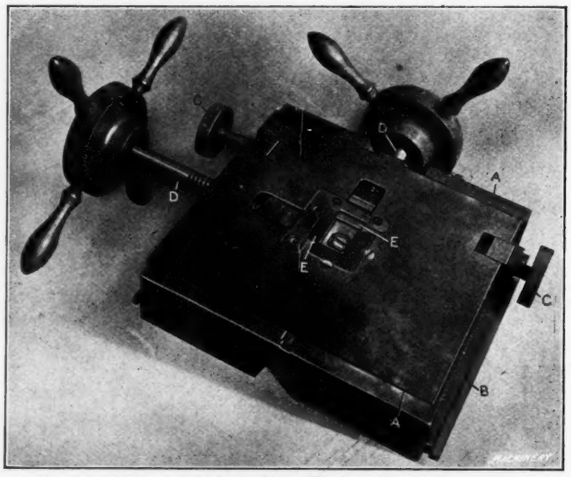


Fig. 8. Fixture used for holding Work while forcing "Hubs" into Mold Sections

casting the plates with a special brass mixture. Different methods of finishing are employed to add to the attractive appearance of the nameplates. In some cases, the Schoop process of spraying molten metal onto the surface of the plate is employed, and where this process is followed, the surface of the plate may be coated with copper, silver or other metals of distinctive color. In other cases, it is found desirable to electroplate the nameplates. After the metal coating has been applied, the plates are lacquered to give them the final finish.

It is often required to have the letters of one color and the background of another, and to secure this result the entire nameplate is sprayed with the colored lacquer which is required for the background. While the lacquer is still wet, the surface of the plate is wiped with a soft cloth which removes the lacquer from the faces of the raised letters, exposing the surface of the metal to give the letters the distinctive color of the metal from which the plate is made. Then after the first coat of lacquer is dry, the entire plate is again sprayed with white lacquer to give the final finish. The combination of different decorative effects, a border and an artistic background, in connection with the required lettering on a nameplate, naturally adds greatly to its appearance. The background may be of "basketwork" design, stippled, or of any other pattern required, or it may be left plain. When it is taken into consideration that these features are obtained by a method which enables nameplates to be made without any charge for engraving the mold, it will be evident that this process of die-casting in sectional molds is one which is destined to be of far-reaching importance to the mechanical public.

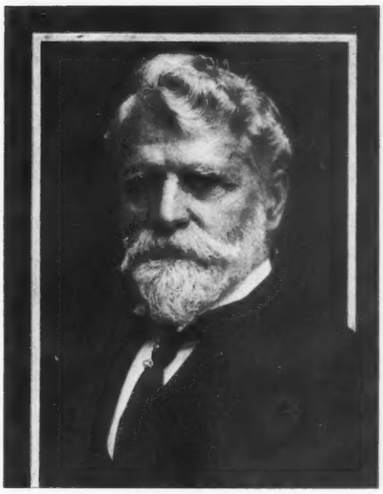
* * *

AMBROSE SWASEY

Ambrose Swasey, the donor of the initial fund of $200,000 for the Engineering Foundation, inaugurated at the Engineering Societies Building, January 27, as mentioned in the February number of MACHINERY, is widely known as a member of the firm of Warner & Swasey, builders of machine tools and telescopes, of Cleveland, Ohio. He was born in Exeter, N. H., his ancestors being among the early settlers of New England, having come to America in 1638. He received his education in the "little red school house" of the district. At the age of eighteen he entered upon the machinists' trade in Exeter, and in 1870 he entered, together with his present partner, W. R. Warner, into the employ of the Pratt & Whitney Co., Hartford, Conn. Here his energies and ability soon became manifest, and his aptness in the solution of mechanical problems was so thoroughly appreciated that the expression "send it up to Swasey" became a standing phrase in the factory. While in charge of the gear-cutting department of this company he invented and perfected an epicycloidal milling machine for producing true theoretical gear-tooth curves, and also developed an entirely new process for generating and cutting spur gears.

In 1880 Mr. Swasey resigned his position with the Pratt & Whitney Co., and together with Mr. Warner established the firm of Warner & Swasey, in Cleveland, Ohio. This business has grown to be one of the prominent machine tool plants in the country, and is also well known as the leading plant in the world for the building of telescopes. Among the instruments which have been designed by the firm of Warner & Swasey are the famous Lick, Yerkes, and United States Naval Observatory telescopes, as well as the great 72-inch reflecting telescope for the Canadian government, which is now under construction. The achievements in the machine tool building field are too well known to need comment.

Mr. Swasey is known also, in addition to his engineering achievements, for his practical efforts toward scientific education and the advancement of the engineering profession, and his gift for the establishment of the Engineering Foundation indicates clearly the deep interest and profound sincerity of his efforts. Nor is this Mr. Swasey's first gift for purposes of this kind. He gave a handsome observatory to the Denison University at Granville, Ohio, and the science building for the University of Nanking, China, as well as a Young Men's Christian Association building at Canton, China. He has also interested himself earnestly in the establishment and conduct of the Warner & Swasey apprentice school.



Ambrose Swasey

Mr. Swasey is the inventor of a number of instruments used by the government in its coast defense, including several improvements in the construction of range finders. Many honors have come to Mr. Swasey for his work and achievements. He is a past president of the American Society of Mechanical Engineers, a member of the Institution of Mechanical Engineers of Great Britain, and of the British Astronomical Society, a Fellow of the Royal Astronomical Society, and past president of the Cleveland Engineering Society. In 1900, he received from the French government the decoration of the Legion of Honor for his achievements in the design and construction of astronomical instruments, several of which are installed at the leading observatories in Europe. He was a member of the jury of awards at the Nashville, the Pan-American and the St. Louis expositions, and vice-president of the jury of awards at the Jamestown Exposition. He has also been president of the Cleveland Chamber of Commerce, and the degree of Doctor of Engineering has been conferred upon him by the Case School of Applied Science at Cleveland.

* * *

CLASSIFICATION OF ALLOYS

A number of different societies and commercial bodies interested in metal alloys have, of late, made attempts at classifications and nomenclatures for metal alloys. There are a few general principles with relation to the names of alloys which are quite generally recognized and which, if adhered to, would avoid much confusion. Of course there is a clear distinction between ferrous and non-ferrous alloys. The former contain iron as their chief component, while the latter do not. The most important of the ferrous alloys are generally known as alloy steels. Of the non-ferrous alloys, bronze and brass are the most important. Bronze, properly defined, is an alloy consisting of copper and tin in variable proportions in which, however, the copper is the chief component. Brass is an alloy consisting of copper and zinc in variable proportions in which the copper also is the chief component. Many authorities claim that when a third metal is added to brass or bronze, the alloy should be termed a composition; thus a bronze composition would be an alloy of copper and tin with one or more variable components, but in which tin is the chief minor component. A brass composition would be an alloy of copper and zinc combined with one or more other components, but in which the zinc is the chief minor ingredient. In general usage, however, brass and bronze compositions are frequently known simply as brasses and bronzes. Of other alloys generally used, the white metal alloys occupy an important position. These are combinations of any two white metals. If a combination of two white metals is combined with one or more other variable minor components, the alloy is known as a white metal composition. Amalgam is an alloy of mercury with other metals.

* * *

CORRECTION

Through an error it was stated in the February number of MACHINERY that T. B. Pierce, who died December 19, was superintendent of the Boston Gear Works, Boston, Mass. Mr. Pierce was superintendent of the Grant Gear Works, Boston.

WIRE SPRINGS*

DATA FOR DETERMINING THE PROPERTIES OF WIRE SPRINGS

BY EGBERT R. MORRISON†

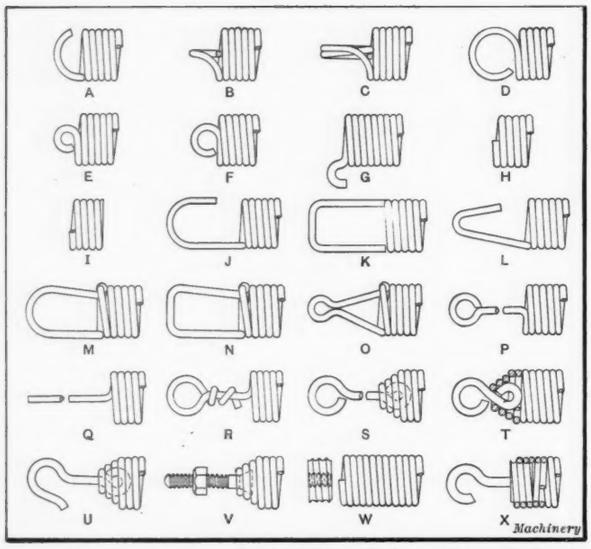


Fig. 1. The Spring A has a Regular Machine Hook over Center; B, Regular Hand Loop over Center; C, Double-coil Hand Loop over Center; D, Regular Hand Loop at Side; E, Small Eye at one Side; F, Small Eye over Center; G, Small Hook at one Side; H, Plain End; I, Ground End; J, Long Hook; K, Long Square Hook; L, V-hook; M, Loop knotted or secured to Spring; N, Square Loop knotted or secured to Spring; O, Knotted Eye; P, Extended Eye; Q, Straight End (usually annealed so that it can be twisted); R, Annealed End, eyed and twisted; S, Tapered End with Extended Swivel Eye; T, Tapered End with Regular Swivel Eye; U, Tapered End with Swivel Hook; V, Tapered End with Swivel Bolt; W, Plain End with Plug to screw into Place; and X, Plain End with Hooked Plug.

WIRE is classified by gage, a certain gage meaning a wire that will pass through a standard sized hole or slot. These holes or slots are numbered; thus a No. 10 wire will pass through the No. 10 hole in the gage. From this it will be clear that wires are not identified by their actual diameters as in the case of round bar stock. If there were only one wire gage in general use, this method of specifying wire sizes would be less confusing; but unfortunately there are several gage systems which were originally developed by workers in different trades or shops, and each of these is in more or less general use. The more common of these wire gages are: (1) American, or Brown & Sharpe; (2) Birmingham, or Stubb's iron wire; (3) Washburn & Moen; (4) Stubb's steel wire; (5) American screw gage; and (6) steel music wire. As a complete series of wire sizes are made in accordance with each of these systems, and as only the more widely used systems are mentioned in the preceding list, it will be evident that the different sizes of wire are numerous and that these sizes over-lap each other.

Impracticability of a Complete Table

In arranging a table of springs which are made from rods, the table may be laid out according to the sizes of the rods, *i.e.*, 1/4, 5/16, 3/8 inch in diameter, etc. Then the properties of the springs may be tabulated under each size of rod, according to the outside diameter of the spring, *i. e.*, 4 inches, 4 1/16 inches, 4 1/8 inches, etc. In such cases intervals of 1/16 inch in the outside diameter of the spring or in the diameter of the bar from which the spring is made, is the smallest variation required for all ordinary cases. No such method can be followed in working out a table of wire springs, however, because the different wire gages in common use are too numerous and the variations in the diameters of the springs are infinite, the spaces being very erratic and often consisting of infinitesimally small differences. Moreover, the variation of any dimension by even 1/32 inch may be entirely too great when compared with the size of the spring, as some wire springs are so small that it requires several thousand of them to weigh one ounce. The best that can be done is to resort to a makeshift and develop an approximate table which will give a good idea of the properties of any given spring. In addition to the trouble resulting from different wire gages in common use, a further difficulty is encountered owing to the fact that springs are made of all kinds of material—such as aluminum, brass, bronze, steel, etc.—and there are no standard grades of wire for this purpose, as in the case of rods where the Pennsylvania Railroad specifications for spring steel are recognized as a standard. On this account we can only base the data in a wire spring table on a certain specified fiber stress and leave it to the engineer to use that as a basis where a different fiber stress must be used.

The Spring Index

No matter what the size of the wire or the diameter of the spring may be, it is always possible to arrive at the value of a ratio which is known as the "spring index." This ratio is given by the following:

$$\text{Spring index} = \frac{D}{d}$$

where D = outside diameter of spring;
d = diameter of wire.

A wire spring table containing all values of the spring index $\frac{D}{d}$ would, of course, be infinitely long and include infinitely small differences, so that any practical table must omit many possible values. Consequently, reference to the table will often result in failure to find the exact value of the spring index $\frac{D}{d}$ that is wanted. In such cases the nearest value will serve to give a fair idea of the actual spring properties, and

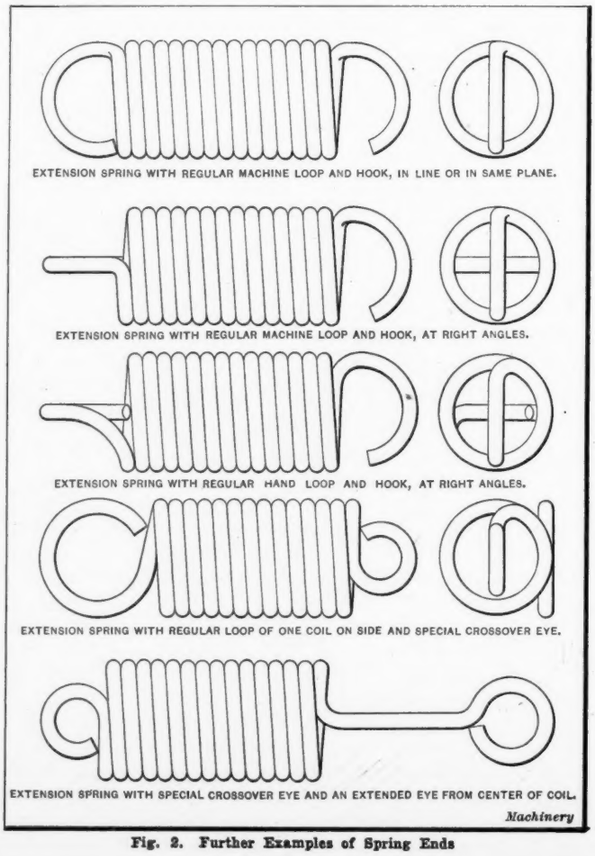

EXTENSION SPRING WITH REGULAR MACHINE LOOP AND HOOK, IN LINE OR IN SAME PLANE.
EXTENSION SPRING WITH REGULAR MACHINE LOOP AND HOOK, AT RIGHT ANGLES.
EXTENSION SPRING WITH REGULAR HAND LOOP AND HOOK, AT RIGHT ANGLES.
EXTENSION SPRING WITH REGULAR LOOP OF ONE COIL ON SIDE AND SPECIAL CROSSOVER EYE.
EXTENSION SPRING WITH SPECIAL CROSSOVER EYE AND AN EXTENDED EYE FROM CENTER OF COIL.
Machinery

Fig. 2. Further Examples of Spring Ends

* For additional information on spring design and allied subjects published in MACHINERY see: "Slide-rule for Spring Calculations," July, 1913; "Winding Piano Wire Tension Springs," April, 1913; "The Design of Conical Helical Springs," May, 1912; "The Design of Grouped Helical Springs," March, 1911; "The Design of Flat Spiral Springs," July, 1910; "Slide-rule for Helical Spring Calculations," March, 1910; "Helical Springs," January, 1909; "The Design of Springs for Gas Engine Valves," May, 1908; and "Hardening and Tempering Coil Springs," May, 1902.

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will generally be close enough to answer all practical purposes. In order to use the spring table which is presented in this connection, the first step is to calculate the value of $\frac{D}{d}$ for the required spring, and also the value of d^2. The second and fourth columns of the table contain constants which are multiplied directly by the solid height of the spring, but the values in the third and fifth columns of the table must be multiplied by d^2. If the weight of the spring is required, it is also necessary to multiply by the solid height of the spring. The results presented in the table are based upon a value of 80,000 pounds per square inch for the fiber stress and a torsional modulus of 12,600,000.

To make the method of procedure quite clear, we will calculate the properties of a wire spring to be made of spring steel which has a safe fiber stress of 80,000 pounds per square inch, the diameter d of the wire being 1/16 inch and the outside diameter D of the spring, 3/16 inch. The solid height of the spring is to be 1¼ inch. It is required to know: (1) the length of wire necessary to make the spring; (2) the weight of the wire in the spring; (3) the free height of the spring; and (4) capacity of spring. With this, we find,

$$\text{Spring index } \frac{D}{d} = \frac{3/16}{1/16} = 3$$

$$d^2 = [1/16]^2 = \frac{1}{256}.$$

Now referring to the table for a value of 3 for the spring index $\frac{D}{d}$, the required length of wire to make the spring is found to be (from the second column of the table):

$$1\tfrac{1}{4} \times 9.4248 = 11.78 \text{ inches.}$$

From the third column, the weight of this wire is found to be:

$$\frac{1}{256} \times 2.0973 \times 1\tfrac{1}{4} = 0.0102 \text{ pound.}$$

From the fourth column, the free height of the spring is found to be:

$$1\tfrac{1}{4} \times 1.1795 = 1.47 \text{ inch.}$$

From the fifth column, the capacity of the spring is found to be:

$$\text{Capacity } \frac{1}{256} \times 10{,}472 = 41 \text{ pounds per coil.}$$

WIRE SPRING TABLE

Weight per inch of solid height equals $A \times d^2$. Capacity of coil equals $B \times d^3$, where d is the diameter of wire in inches.

$\frac{D}{d}$	Length per Inch of Solid Height	Weight per Inch of Solid Height A	Free Height per Inch of Solid Height	Capacity B	$\frac{D}{d}$	Length per Inch of Solid Height	Weight per Inch of Solid Height A	Free Height per Inch of Solid Height	Capacity B
3	9.4248	2.0973	1.1795	10,472	6 1/16	19.0460	4 2383	1.7331	5182
3 1/16	9.6212	2.1410	1.1871	10,258	6 1/8	19.2423	4.2820	1.7483	5129
3 1/8	9 8175	2.1847	1.1948	10,053	6 3/16	19.4386	4.3257	1.7636	5077
3 3/16	10.0138	2.2284	1.2027	9,856	6 1/4	19.6350	4.3694	1.7791	5027
3 1/4	10.2102	2.2721	1.2107	9,666	6 5/16	19.8314	4.4131	1.7948	4977
3 5/16	10.4066	2.3158	1.2189	9,484	6 3/8	20.0277	4.4567	1 8106	4928
3 3/8	10.6029	2.3595	1.2272	9,308	6 7/16	20.2240	4.5004	1.8266	4880
3 7/16	10.7992	2.4031	1.2357	9,139	6 1/2	20.4204	4.5441	1.8427	4833
3 1/2	10 9956	2.4468	1.2443	8,976	6 9/16	20.6168	4.5878	1.8590	4787
3 9/16	11.1920	2.4905	1.2531	8,819	6 5/8	20.8131	4.6315	1.8754	4742
3 5/8	11 3883	2.5342	1.2621	8,666	6 11/16	21 0094	4.6752	1.8920	4698
3 11/16	11.5846	2.5779	1.2712	8,520	6 3/4	21 2058	4.7189	1.9088	4654
3 3/4	11 7810	2.6216	1.2805	8,378	6 13/16	21.4022	4.7626	1.9257	4612
3 13/16	11.9774	2.6653	1.2899	8,240	6 7/8	21.5985	4.8063	1.9428	4570
3 7/8	12.1737	2.7090	1.2995	8,107	6 15/16	21.7948	4.8500	1.9600	4528
3 15/16	12.3700	2.7527	1.3092	7,979	7	21.9912	4 8937	1.9774	4488
4	12 5664	2.7964	1.3191	7,854	7 1/16	22.1876	4.9374	1 9949	4448
4 1/16	12.7628	2.8401	1.3292	7,733	7 1/8	22.3839	4 9811	2.0126	4409
4 1/8	12.9591	2.8838	1.3394	7,616	7 3/16	22.5802	5.0248	2 0304	4371
4 3/16	13.1554	2.9275	1.3498	7,502	7 1/4	22.7766	5.0685	2.0484	4333
4 1/4	13.3518	2.9712	1.3603	7,392	7 5/16	22.9730	5.1122	2.0666	4296
4 5/16	13.5482	3.0149	1 3709	7,285	7 3/8	23.1693	5.1558	2.0849	4260
4 3/8	13.7445	3.0586	1.3818	7,181	7 7/16	23.3656	5.1995	2.1033	4224
4 7/16	13 9408	3.1022	1.3928	7,080	7 1/2	23.5620	5.2432	2 1220	4189
4 1/2	14.1372	3.1459	1.4039	6,981	7 9/16	23.7584	5.2869	2.1407	4154
4 9/16	14.3336	3.1896	1.4152	6,886	7 5/8	23.9547	5.3306	2.1597	4120
4 5/8	14.5299	3.2333	1.4267	6,793	7 11/16	24.1510	5.3743	2.1788	4087
4 11/16	14.7262	3.2770	1.4383	6,702	7 3/4	24.3474	5.4180	2.1980	4054
4 3/4	14.9226	3.3207	1.4500	6,614	7 13/16	24.5438	5.4617	2.2174	4021
4 13/16	15.1190	3.3644	1.4620	6,528	7 7/8	24.7401	5.5054	2.2370	3938
4 7/8	15.3153	3.4081	1.4740	6,444	7 15/16	24.9364	5.5491	2.2567	3958
4 15/16	15.5116	3.4518	1.4863	6,363	8	25.1328	5.5928	2.2765	3927
5	15.7080	3.4955	1.4987	6,283	8 1/16	25.3292	5.6365	2 2966	3897
5 1/16	15.9044	3.5392	1.5112	6,206	8 1/8	25.5255	5.6802	2.3167	3867
5 1/8	16.1007	3.5829	1.5239	6,130	8 3/16	25.7218	5.7239	2.3371	3837
5 3/16	16.2970	3.6266	1.5367	6,056	8 1/4	25.9182	5.7676	2.3576	3808
5 1/4	16.4934	3.6703	1.5498	5,984	8 5/16	26.1146	5.8112	2.3782	3779
5 5/16	16.6898	3.7140	1.5629	5,916	8 3/8	26.3109	5.8549	2.3990	3751
5 3/8	16.8861	3.7576	1.5763	5,845	8 7/16	26 5072	5.8986	2.4200	3723
5 7/16	17.0824	3.8013	1.5897	5,748	8 1/2	26.7036	5.9423	2.4411	3696
5 1/2	17.2788	3.8450	1.6034	5,712	8 9/16	26.9000	5.9860	2.4624	3669
5 9/16	17.4752	3.8887	1.6171	5,648	8 5/8	27.0963	6.0297	2.4838	3642
5 5/8	17.6715	3.9324	1.6311	5,585	8 11/16	27.2926	6.0734	2 5054	3616
5 11/16	17.8678	3.9761	1.6452	5,524	8 3/4	27.4890	6.1171	2.5271	3590
5 3/4	18.0642	4 0198	1.6595	5,464	8 13/16	27.6854	6.1608	2.5490	3565
5 13/16	18.2606	4.0635	1.6739	5,405	8 7/8	27 8817	6.2045	2 5711	3540
5 7/8	18.4569	4.1072	1.6884	5,347	8 15/16	28.0780	6.2482	2.5933	3515
5 15/16	18.6532	4.1509	1.7032	5,291	9	28.2744	6 2919	2.6156	3491
6	18.8496	4.1946	1.7187	5,236	...	.....	.....	.....	....

Machinery

Wire springs are likely to be very small; for instance, the writer has one particular spring in mind which was so small that 38,000 were required to weigh one pound. For measuring wire of any kind, it is better to use a micrometer caliper, thus recording the dimensions in decimal parts of an inch, instead of attempting to use gages of any kind.

Initial Tension

Springs are often made with an "initial tension" which causes the coils to be drawn tightly together. This result is secured by twisting the wire, a common example of a spring of this type being the ordinary screen door spring. Such springs will not begin to deflect as soon as the load is applied, it being necessary to first overcome the initial tension already in the spring. With springs of this type it is possible to load to the maximum capacity without obtaining a corresponding deflection of the spring.

Methods Used in Spring Manufacture

Wire springs are made of a great variety of materials, and the wire is generally sold under a trade name. The manufacturer is very willing to guarantee his wire of certain grades, but equally unwilling to guarantee other grades of wire which he makes. In all cases, however, he either cannot or will not state any of the physical properties of his product, contenting himself by saying that it is "extremely uniform." Some manufacturers actually disclaim the possession of such knowledge, while others are frank in stating that exact analyses and corresponding characteristics are regarded as valuable trade secrets. Some manufacturers of both wire and wire springs, even go so far as to state that they make certain grades of wire for their own use and that they will not sell such wire to other spring manufacturers. In such cases it is necessary for the spring manufacturer and his engineer to ascertain by experiment just what any grade of wire will do. In this way an exact average of the physical properties of the wire is obtained.

Spring Ends

Extension springs are furnished with an infinite number of different kinds of ends, many of which have become so commonly known in the trade that they are regarded as standard. The two hooks at opposite ends of a spring may be made in line and in the same or different planes; and they may be located at the center of the spring or on one side. A further variation may be obtained by arranging the ends out of line and they may even be located at right angles to each other. Some common forms of spring ends are illustrated in Figs. 1 and 2, and in referring to these illustrations it will be well to remember that the direction in which the springs should be wound ought always to be specified when giving an order. It must also be borne in mind that tables and calculations of the form presented in this article apply only to the flexible part of the spring. Ends of various kinds, such as hooks, plugs, etc., are really not part of the spring proper, such ends being merely mechanical appliances for attaching the spring to other machine elements.

* * *

A patent has recently been granted to S. W. Parr, Urbana, Ill., for a new alloy claimed to resist the corrosive action of moist oxygen or of ordinary acids. Hence, it can be used in calorimeters and exposed directly to the calorimeter charge. Bomb calorimeters ordinarily used are made of steel with the inner faces lined with platinum or gold plated copper, having the disadvantages of high cost and being easily damaged. The new alloy has a composition of 63 parts nickel, 5 parts copper, 20 parts chromium, 5 parts molybdenum, 2 parts tungsten and less than 2 parts each of aluminum, boron and manganese. It is claimed to have a very high electrical resistance, and to have a tensile strength for unworked metal of about 60,000 pounds per square inch. It may be used for valve seats and for the construction of chemical vessels, taking the place of platinum for certain purposes.

* * *

An error of statement was made in the article, "The Story of the Combination Square," which appeared in the January number in regard to the interview of Mr. Starrett with Samuel Colt. The interview was not with Mr. Colt, but with a representative of Colt's Armory. Mr. Colt had been dead a number of years at the time of the interview.

ANNEALING BRASS FOR FORMING AND DRAWING OPERATIONS

BY HOWARD W. DUNBAR*

Difficult forming and bending operations as performed under a punch press have and always will cause considerable trouble, especially when a large number of successive operations must be performed. A lot of time must be spent in producing the exact shape on the dies, fussing with corners and removing a thousandth here and a thousandth there. The material next comes in for its criticism, and we finally select a grade which is correct in composition and whose physical properties should insure satisfactory results. We anneal the parts—a number of times perhaps—and sometimes we have them annealed after each operation, but still we fail either to succeed in producing any parts at all, or the majority of these parts develop cracks in making some

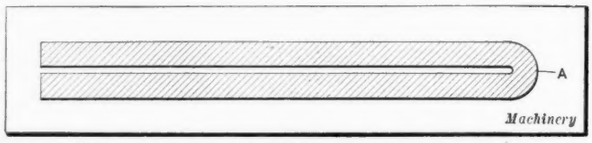

Fig. 1. Piece of Work which gave Trouble at Bend A

of the bends or forming operations. The fact I wish to bring out is that we are very particular with most of the variables which enter into difficult forming and drawing operations, and then promptly proceed to neglect a most important one—annealing. Frequently very little thought is given to the effect annealing can have upon the forming and drawing operations. We permit the annealing foreman to establish the temperature, and then are content to let the man at the fire gage the temperature with his eye (and it is admitted that an annealing expert becomes skilled in this respect) and use his own judgment as to the length of time the parts are left in the furnace. How do we qualify him to do this? He seldom has an opportunity to gain experience with the actual operations on the parts he is treating, nor in many cases does he know the results which are to be accomplished through the medium of the annealing operation. He seldom, if ever, knows the exact composition of the material which he is handling; it is brass and brass alone to him.

Now there are many variables, both of a personal nature and of a tangible nature, and all should be given proper consideration before the most desirable results can be expected. Let us consider some of those which have a bearing upon the requirements of an efficient annealing operation. (1) The composition of the brass, *i. e.*, whether it be high or low in lead, and the amount of zinc which plays an important part in determining the temperature at which this material should be annealed to produce good uniform results in a bending or forming die. As the lead and zinc melt at a low temperature, they naturally are more quickly affected by overheating, and the higher the percentage of these two metals in the mixture, the more is the brass structure changed by variations in temperature. (2) The length of time that these parts are left in the furnace under this temperature. Of course the temperature can be higher or lower (within reason) if the time the parts are left in the furnace is varied to suit such differences. Still, with a given temperature, observations have shown that the time cannot vary more than 5 per cent. (3) The manner of cooling. (4) The varia-

Fig. 2. Structure of Brass that was overheated in annealing by the "Hit or Miss" Method

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tions in temperature throughout the heat. In most difficult forming operations, especially where there are a large number of successive drawing or bending operations to be performed, the temperature during the annealing operations cannot vary materially. Thirty degrees in some cases is the limit. (5) The nature of the bend, *i. e.*, whether it be a severe one or one more readily accomplished. This naturally affects the number of annealing operations, which should be held down to a minimum, as the more annealings introduced the more chances there are for changing the structure of the brass by overheating.

How can these variables be controlled, and what advantages can be obtained by such control? To emphasize this point, and incidentally to illustrate the importance of attention to that part of the work connected with difficult forming operations, which is now so sadly neglected in many cases, let me give an illustration of an actual experience which came under my observation. A small brass part made from sheet stock approximately 3/32 inch thick was to be formed by perhaps fifteen or sixteen different operations to a very irregular and difficult shape, and the particular operation with which considerable trouble was experienced is illustrated in Fig. 1. The brass had to be bent back on itself, leaving a very small space between the parts; two operations at this particular point had preceded the one in question. The material from which the part was made was what is known to the trade as "soft draw" brass, and contained a minimum amount of lead (about 0.5 per cent) with the general mixture for zinc and copper, the impurities being reduced to a minimum. It was the best material known to makers of brass, for the purpose for which it was to be used, but still the parts could not be formed so that point *A* did not show cracks.

Considerable time, thought and worry were put into the many troubles as they came up. The cost of the investigation ran up to thousands of dollars in wasted material and changes in tools and fixtures, every change seeming to point toward a solution of the difficulties, but little actual improvement was noticed until one day it occurred to me that perhaps our trouble did not lie in what seemed to be the apparent cause—the mechanical operation. Perhaps there was some other reason for the difficulty, and we naturally turned to the only other possible source of trouble, *i.e.*, the annealing department, after having exhausted all imaginary experiments in materials and tools. I discovered in the annealing department, and no doubt similar discoveries can be made in practically all such departments, a sadly neglected state of affairs. Temperatures ranging from 1000 to 1650 degrees were commonly used. Sometimes the part remained in the furnace a very short time, and at other times for a longer period. It is true that occasionally parts were properly annealed, and when properly annealed no trouble resulted. This constituted that percentage which had been all right.

A systematic study was made of the conditions pertaining to the particular operation in question. A pyrometer was installed to indicate the temperature, which helped to maintain it at a given figure, and hold it within a limit of twenty degrees. This instrument was of the recording type, so that any fluctuations in temperature could be traced, and if trouble resulted from parts annealed at any particular time, the cause could be traced and corrected. A mechanical device was installed which carried the parts into the furnace, allowed them to remain there for a certain length of time, and then automatically carried them out and dropped them into the water tank for cooling. This insured that the parts only remained in the furnace for the time desired; and the speed of this mechanical device could be regulated within a range which was considered sufficient to cover the case. Of course a great number of experiments had to be performed, but the results were that after the temperature was once determined, the length of time the parts were allowed to remain in the furnace was fixed, and all parts that came to the dies in this state were formed to their proper shapes without defect.

Fig. 3. Same Brass shown in Fig. 2, illustrating Improved Structure obtained by Proper Annealing Conditions

Figs. 2 and 3 show reproductions of micro-photographs of the surface of a piece of brass after the annealing operation. In both illustrations the same grade of brass was photographed, and these photographs were taken at the same time, the magnification being 80 diameters in each case. Fig. 2 illustrates the surface of the brass as seen under the microscope when annealed by the hit or miss process that was in vogue previous to the investigation. The temperature of the furnace during the annealing operation was stated to be 1500 degrees and the parts remained in the furnace at this temperature for a length of time varying from two to seven or eight minutes. An examination of the manner in which the material has crystallized will readily reveal the fact that the stock was very much overheated, and that the materials are separated, leaving large crevices, which, it is obvious, would cause cracks or breaks in the bending operation. A glance at Fig. 3 will at once show the improvement accomplished when proper attention was given the annealing operation. The closeness of the grain, as compared with Fig. 2, immediately impresses upon one the importance of the annealing operation. The temperature as indicated by the recording pyrometer, was held from 1150 to 1180 degrees, and the parts remained in the furnace at this temperature for a period of three minutes, thirty seconds, when they were plunged into lukewarm water and accordingly cooled. The brass in both cases analyzed the same, and an interesting point is that when tested with the scleroscope, both showed the same hardness, indicating that the mere softening of the brass is not the only object sought.

This example serves only as one illustration of many similar cases which were at once revealed in succeeding experiments on other bending and forming operations which were giving similar trouble. After once establishing a uniform condition of annealing, and arranging it in such a manner that when parts were not annealed according to instruction, this fact was revealed through the recording pyrometer and recording time indicator, bending troubles at once vanished. Dies which formerly were condemned as not being capable of producing correct shapes were pressed into service and proved not only useful but satisfactory. Operations which were a variable quantity on the production sheet, because of large percentage in loss, at once became normal and ceased to be a trouble. Four marked improvements were noticeable as a result of this investigation: (1) Tool wear (within reasonable limits) ceased to be a factor. (2) Output immediately increased. (3) A wider variation in the composition of the stock was permissible. (4) Percentage of scrap pieces due to cracks or breaks was reduced to 0.5 per cent.

Are not these results of sufficient importance to make the subject of annealing brass worthy of serious consideration?

* * *

Engineering science, which has done probably more than any other material agency to build up and make possible our present civilization, is also used as the main agency in destroying it, because war has become mainly a skillful use of the devices provided by the engineer. The part that the mechanical, electrical, civil and naval engineer plays is easy to recognize, but even the mining engineer comes in for his share. We are told that at one point in France, where the opposing trenches were very close together, and where the French were "much annoyed" by the fire of German machine guns, which were inaccessible to the French fire, some mining engineers and coal miners drove a tunnel to the spot where the machine guns were located and succeeded in blowing up the cause of the "annoyance."

ELECTRIC BUTT-WELDING PRACTICE*—1

APPLICATION AND PRACTICE OF JOINING METALS BY ELECTRIC WELDING MACHINES

BY DOUGLAS T. HAMILTON†

WHILE practically all metals and alloys can be electrically butt-welded, it is necessary to adopt different methods of clamping the work and applying the current to make a perfect union with metals of relatively low resistance. Copper, for instance, requires a large amount of electric current for a short period of time, whereas aluminum can only be satisfactorily welded with a current that is

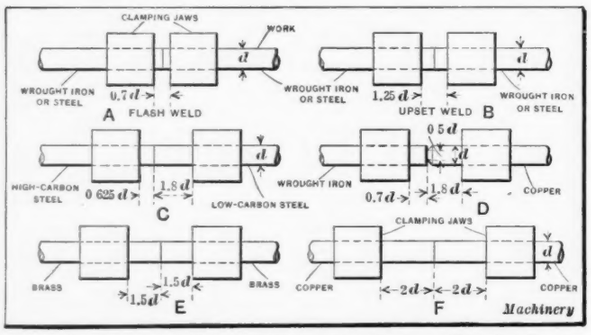


Fig. 1. Diagram showing Projection of Work from Clamping Jaws for welding Different Kinds of Material and for making Various Types of Welds (Toledo Electric Welding Co.)

under perfect control and is cut off at the precise moment that the metals are homogeneously united. The protrusion of the metals from the clamping jaws also governs, to a certain extent, the effectiveness of the electric welding machine.

Projection of Work from Clamping Jaws

In butt-welding, the work is allowed to project a certain distance out from the faces of the clamping jaws, and then when it has become heated to the proper temperature the jaws are forced together until, in some cases, they practically contact. The amount of metal left projecting is determined largely by the material to be welded and the type of weld desired.

Fig. 1 shows the relative positions of the clamping jaws and the amount that the work should project from them for welding various materials. At *A* is shown the amount that the stock should project from the clamping jaws when making a flash weld on round or bar stock. This applies to the welding of wrought iron or steel. The space between the two jaws should equal about 0.7 times the diameter of the work. The distance is never greater than the diameter of the stock for making a flash weld. A flash weld is generally used on stock that is wide and thin, and is sometimes advisable when the welding faces are not cut square and true. It is also used in welding tubing to tubing; in fact, in all cases where a small amount of stock is to be taken up in the weld, or when it is desired to shear or grind off the fin.

For making an upset weld, the stock should project from the jaws about the distance shown at *B* in Fig. 1. The amount of metal generally left extending from the jaws for making an upset weld of wrought iron or steel is about 1¼ times the diameter of the work. Upset-welding is used in all cases where the weld is to be hammered, using the heat generated in welding; also in some cases on small rods or rings where it is not necessary to have a uniform thickness of stock. In welding materials such as copper, brass, tool steel and other metals that are deteriorated by high temperatures, they must be heated quickly and pressed together with sufficient force to push out all the burnt metal from the weld.

When welding high-carbon steel to low-carbon steel, the stock should extend from the jaws about as indicated at *C*, Fig. 1. The low-carbon stock should extend considerably farther than the high-carbon stock, the high-carbon stock generally extending about 0.62 times the diameter of the work, and the low-carbon stock about 1.8 times the diameter of the stock. The reason for this is that the high-carbon stock offers much greater resistance to the passage of the electric current than the low-carbon stock does and hence heats up quicker.

When welding wrought iron to copper, it is necessary for the work to be held as shown at *D* in Fig. 1. The wrought iron should project from the jaws about 0.7 times the diameter of the work, and the copper about 1.8 times the diameter. The copper should preferably be reduced on the end to about 0.5 times the diameter of the bar. In this case, the copper is a better conductor of the electric current than the wrought iron and, consequently, does not heat up as quickly. The cross-section of the copper is therefore reduced to increase its resistance to the passage of the electric current and cause it to heat up quicker or at about the same rate as the wrought iron.

In welding one brass rod to another brass rod, the clamping jaws should be set apart about three times the diameter of the rod, as indicated at *E* in Fig. 1. The weld, however, only takes up about one times the diameter of the bar, when the bar is over ¼ inch in diameter. In welding copper to copper, the work should project, as shown at *F* in Fig. 1, about four times the diameter of the rod. Here again only about one times the diameter of the stock is utilized in making the weld, unless the stock is less than ¼ inch in diameter.

Various Arrangements of the Clamping Jaws

In order to make different types of welds, various arrangements of the clamping jaws are necessary. Fig. 2 shows diagrammatically a number of different arrangements. The views shown are plan views, looking down on the top faces of the jaws. At *A* is shown the typical arrangement of the jaws for making an ordinary butt-welded joint, the work being clamped centrally between the upper and lower clamping jaws and projecting the required amount, as previously described, for various materials.

Sheet or flat stock is usually welded with a machine called a spot-welder, provided with vertical clamping points or electrodes. This process will be fully described in a succeeding article. When the size and shape of the work will permit, however, spot-welding operations can be accomplished on certain materials in a butt-welding machine by employing special arrangements of the clamping jaws as shown at *B* and *C* in Fig. 2. In practice, however, it is found that in some cases the necessary form of jaws on butt-welding machines render them impractical on account of the impossibility of getting the work to be spot-welded into them. For spot-welding in an electric butt-welding machine, the two upper clamping jaws are not used, and one of the lower jaws is pointed as shown at *B*, the other being provided with a flat face. The material having the least resistance to the electric current is placed in contact with the pointed jaw. This form of jaw is used in welding sheet steel, copper and brass, but when galvanized iron is to be spot-welded the faces of both clamping jaws must be pointed.

The arrangement of the clamping jaws shown at *C* in Fig. 2 can also be used in an emergency for performing spot-welding operations on a butt-welding machine. Instead of using the jaws as electrodes, two round copper rods, as shown, are held in them, one of which is pointed for welding steel, brass and copper; both of these must be pointed for welding galvanized iron.

For performing jump-welding operations on light stock, the arrangement shown at *D* in Fig. 2 is used. One piece of work is held parallel with the front faces of the clamping jaws as illustrated, and the other located at right angles to it. The piece of work located at right angles is generally

* See also "Electric Butt-Welding Development" in the February, 1915, number of MACHINERY.

† Associate Editor of MACHINERY.

pointed to reduce the cross-sectional area in order to enable it to heat up at the same time as the other piece, allowing a perfect junction to be made. This arrangement of the jaws is also used for the welding of tubing.

A rather unusual arrangement of the clamping jaws is shown at *E* in Fig. 2. This requires a specially constructed machine provided with two pairs of self-equalizing clamping jaws mounted on the left-hand head and insulated from each other. These two jaws are operated by one vertical lever and are used for gripping the upper part of the "T bar" that is to be welded. The machine is provided with a double-throw switch operated by a foot lever. The making of a tee-weld is accomplished by first heating the stock between the two auxiliary clamping jaws *a* for a distance of about one or two inches. When it is red-hot, the double-throw switch is turned to the left, which changes the flow of the current. The current then travels from the right-hand clamping jaw *b* in which the lower part of the tee is held to the left-hand preheating jaws. When the lower part of the tee is brought into contact with the preheated bar and the current turned on, the two pieces quickly reach the welding temperature; a slight pull on the lever handle forces them together and the job is done.

The diagram at *F*, Fig. 2, shows the arrangement of the clamping jaws and work for forming a square-corner weld. One piece of work is held parallel with the traveling slide of the jaws, and the other at right angles to it. In this case the sectional area of the two pieces is practically equal, so that no preheating of the bars is necessary. It is strictly a straight welding proposition. The flat bar in the right-hand jaw, however, should project out farther from the face of the jaw than the other piece, generally about twice the distance. At *G* another arrangement of the clamping jaws is shown for making a corner weld, but in this case the weld is made at an angle of about 45 degrees, making a right-angle joint. In this arrangement the work is presented differently because of the angles on the work. The jaws are machined out so that they act as a guide to present the two pieces at right angles to each other, and then the welding operation is a comparatively simple process, no preheating of the work being necessary.

The butt-welding of hoops or rings, as shown at *H*, can also be accomplished on a regular butt-welding machine in which the clamping jaws are so arranged as to allow the stock to be presented to them without coming in contact with the frame of the machine. The operation of welding is carried on in the same way as an ordinary butt-welding job.

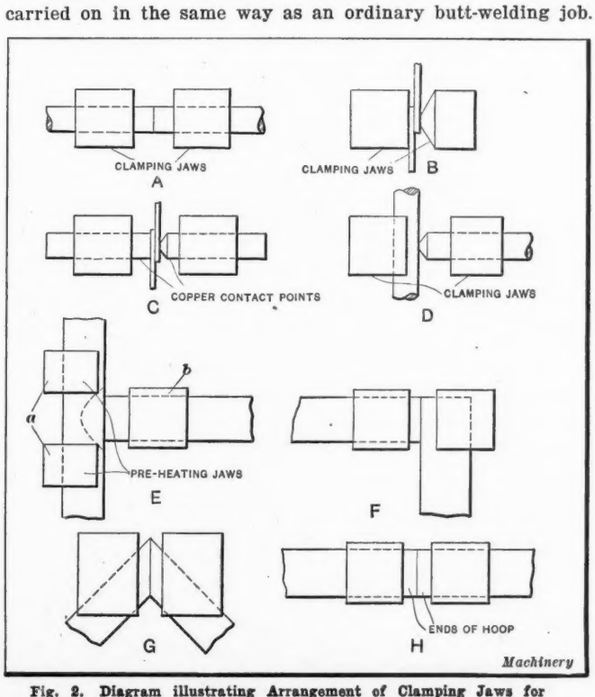


Fig. 2. Diagram illustrating Arrangement of Clamping Jaws for performing Various Types of Welds (Toledo Electric Welding Co.)

A special arrangement of the clamping jaws (patented by the Thomson Electric Welding Co.) for butt-welding thin wide strip stock in a butt-welding machine is shown in Fig. 3. This type of welding would be particularly difficult of accomplishment with clamping jaws of the ordinary shape, as it would be impossible to hold the thin stock close enough to the edge to keep the two edges in alignment and distribute the heat evenly. By constructing the jaws with toothed or intermeshing edges, as shown in Fig. 3, the stock can be supported practically to the edge, as shown at *A*, and still allow space for a burr to be formed at the weld when the jaws come together as shown at *B*.

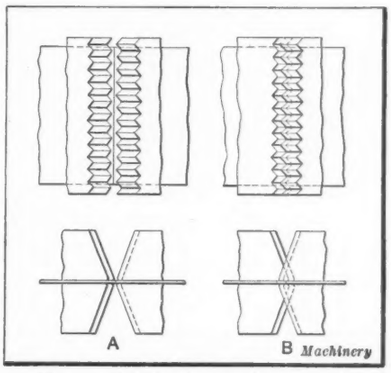


Fig. 3. Method of arranging Clamping Jaws for butt-welding Thin Strip Stock (Patented by the Thomson Electric Welding Co.)

Welding Pieces of Unequal Cross-sectional Area

Fig. 4 shows a machine embodying the necessary apparatus for welding pieces of unequal cross-sectional area, which has been designed and patented by the Thomson Electric Welding Co. This is accomplished by using two transformers, one for heating the thick piece and the other for making the weld. In the illustration, the heating transformer is indicated by *A* and the welding transformer by *B*. *C* is the secondary circuit of the heating transformer; it consists of a metal yoke recessed to receive the primary coil *D* and is bolted to the table top as shown. On one terminal is secured a slide *E* and on the other a slide *F*; these slides carry at their forward ends the lower jaws or work-holding members *G* and *H*. Mounted on slides *E* and *F*, but insulated from them, is an arm *I* on which the other work-holding members *J* and *K* are mounted. These upper clamping jaws are insulated and seated in the free end of the lever *L* which is pivoted to the arm *I*. This lever is depressed by the cam lever *M*.

The welding transformer has its secondary in the plane intersecting that of the heating transformer. It is secured to the table and has one of its terminals projecting and seated between the terminals of the heating transformer from which it is insulated. The other terminal of this secondary has mounted on it a slide *O* which carries at its forward end the lower jaw or work-holder *P*. The upper jaw or work-holder *Q* is carried on the end of lever *R*, which is pivoted to the curved arm *S*, mounted on the slide *O*. A cam lever *T* serves to depress the lever *R*, and a spring returns it substantially to its former position. Anti-friction rollers are located between the base of the machine and the movable arm *S* to facilitate its movement. The work-holders are constructed so that the clamping bases may be readily removed, and are made as small as practical with sufficient contact area to concentrate the lines of force between the terminals of the secondary. The work-holders are also kept cool by circulating water through them. The primaries of the transformers *A* and *B* are connected to a source of electric current in parallel, and each is provided with a switch so that it can be operated independently.

In using this apparatus for welding a thin piece to the side of a thick piece, the latter is clamped between the jaws *G* and *H* and *J* and *K* and the current turned on, thereby heating the portion of the thick piece which lies between the clamps. The abutment *U* and the thin piece can touch the work if desired. The current flows from one terminal *G* to the other terminal *H* and through the work, which is clamped in position by means of the jaws *J* and *K*. When the thick piece is sufficiently heated, it is moved back, together with its clamp, until it bears snugly against the abutment *U*, and at the same time the slide *O* is moved to bring the thin piece of work held in jaws *P* and *Q* up against the thick one.

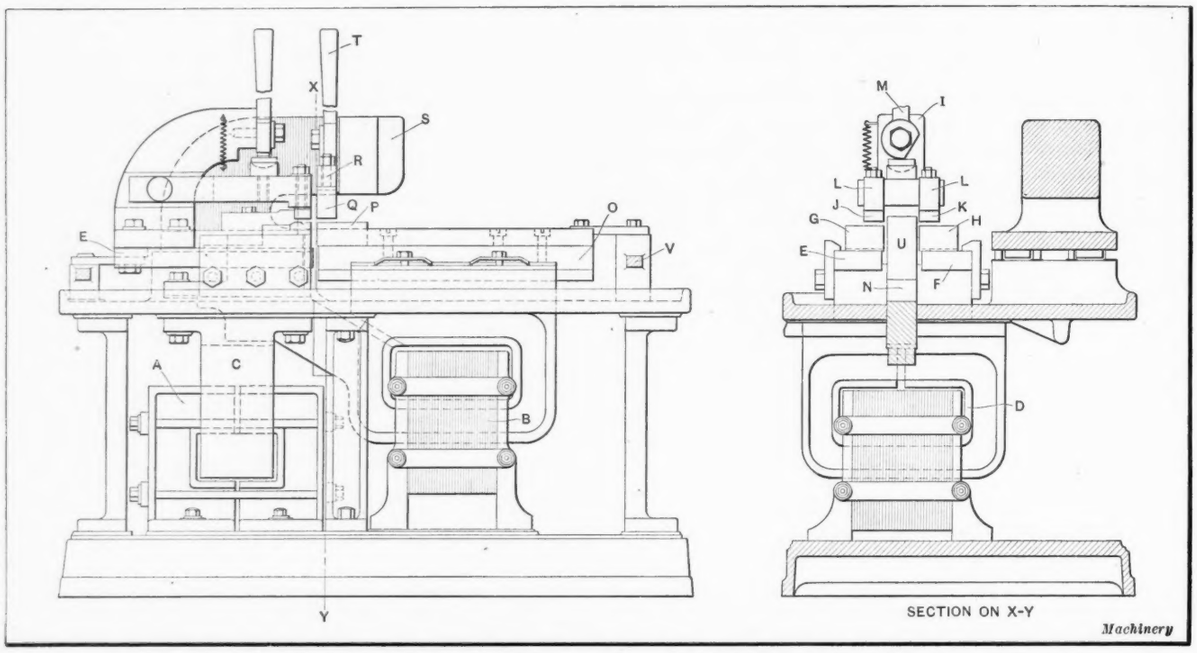


Fig. 4. Special Type of Electric Butt-welding Machine patented by the Thomson Electric Welding Co. for welding Pieces of Unequal Cross-sectional Area. This Machine comprises Two Transformers. (Thomson Electric Welding Co.)

The current is then turned on to the welding transformer *B* and, if necessary, can be turned off from the heating transformer *A*. When the current is turned on to the welding transformer, it flows from the jaw *R* through the abutting pieces of work to the abutment *U*. As the pieces of work soften, suitable pressure is applied to the lever *V* to produce the necessary upset and effect the weld. The current is then turned off and the levers released to free the work.

Tee-welding Thin Strip Stock

In the butt-welding of thin strip stock, it is evident that the top of the tee has much more volume than the end of the lower portion of the tee that is to be welded to it, as is clearly illustrated by the pieces *a* and *b* in Fig. 5. It is desirable to provide a means for localizing the current so that the piece *a* will heat up equally with the piece *b*. The method of accomplishing this is to first heat the piece *a* and then subject it to end pressure to upset it and form a burr or projection as shown. This provides means for localizing the current at the point of welding in the subsequent stages of the operation. The piece *b* is then welded to the piece *a* by bringing the former into engagement with the upset and subjecting it to both heat and pressure. With this type of apparatus it is evident that three sets of clamping jaws are necessary, as has already been described for this work. The condition of the work before and after welding is shown at *A* and *B*. This process of electric welding was patented by the Thomson Electric Welding Co. in November, 1913.

Tee-welding without Changing Original Dimensions of Work

A special application of the electric welding machine, patented by the Thomson Electric Welding Co., to tee- and angular-welding without changing the original dimensions of the work is shown diagrammatically in Fig. 5.

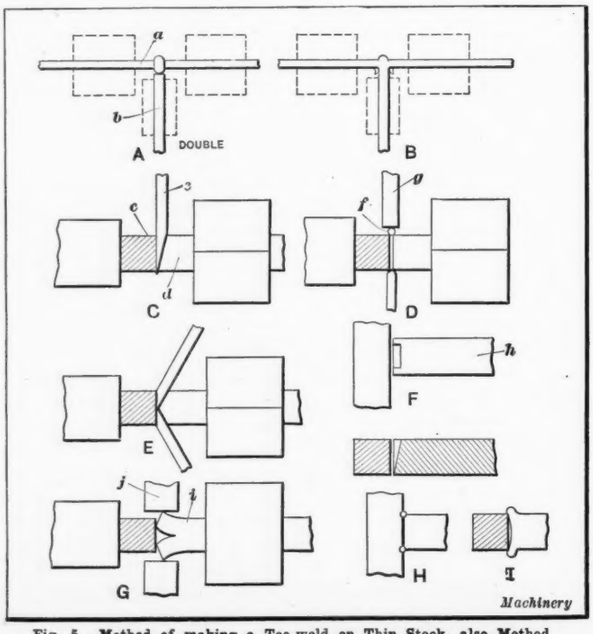


Fig. 5. Method of making a Tee-weld on Thin Stock, also Method of making Tee-welds without reducing Original Dimensions of Parts being welded (Thomson Electric Welding Co.)

This method can be used advantageously in the construction of articles such as metal grills, grids or frames employing a number of cross pieces united to end pieces or pieces common to such cross pieces. In the usual practice of uniting pieces by a butt-welding process, there is, of necessity, a shortening of the piece attendant upon the upsetting of the plastic metal at the joint under endwise pressure. This involves a change in the dimensions of the completed structure, or in other words an alteration in the relative positions of two pieces due to the movement of one toward the other in forming the joint. Hence, in the welding of a frame or grid having two or more cross pieces of definite dimensions, it is evident that, by the ordinary method of butt-welding, a certain amount of the metal is taken up in the upset and hence the pieces would be shortened. The methods illustrated in Fig. 5 consist in holding the pieces to be welded rigidly in their ultimate relative positions and crowding in a uniting material which is made plastic by the passage of an electric current through it. The metal is crowded into the space between the two pieces and fills up the joint, welding the members together.

One method of uniting two members in this manner is shown at *C* in Fig. 5. Here it will be seen that the pieces *c* and *d* to be joined are separated by a wedge *e* which is forced in sideways in the space between the two pieces. This metal may be of the same character as that of *c* or *d* or different according to the kind of joint required. By passing a current through these pieces, the metal wedge becomes plastic and adheres to the pieces, joining them without change of dimensions in the structure or shortening of either of the component parts. Any part that is left projecting from the wedge-shaped piece *e* is cut off after the welding of the joint is completed.

Another method of making the same joint where only moderate strength is required is shown at *D*. In this case a small piece of metal *f* is being crowded into the intervening space between the two pieces by means of the crowding tool *g*. A slightly different application from that shown at *C* is shown at *E* where two pieces instead of one are being used to form the junction. At *F* is shown another method. In this case, it will be seen that a bevel groove is cut in the piece *h*, providing it with a seat for the metal which is inserted to form the junction. Still another method of effecting a tee-weld without any change in the original dimensions of the pieces is shown at *G*, in which the end piece *i* is flared out to provide material which is forced back by means of the crowding tool *j*. In this case, however, it is obvious that the plastic material is not a separate piece, but consists of one of the parts itself. The flare instead of being as shown at *G* can be as shown at *I* and will engage the other piece on the corner instead of in the center, so that the action of the crowding tool will force the metal down into the center when making the junction. Another method of accomplishing the weld is shown at *H* in which the joining metal is applied in small pieces or spots at the corner, this method being especially adapted to the tee-welding of parts where a strong joint is not essential.

* * *

RECENT LEGAL DECISIONS INVOLVING MACHINERY

Of Interest to Exhibitors at San Francisco

(Wisconsin.) Where a manufacturer of machinery places one of his machines on exhibit at an exposition or fair, and the same is installed on a platform, it is the duty of the manufacturer to anticipate that injury might probably result to some person exercising ordinary care, if guard rails are not provided on the steps leading to the viewing platform. Failure to provide such rails is negligence for which he is liable in the case of accident.

The Wisconsin Supreme Court has held the foregoing to be the law in Pennell v. Rumely Products Co. The action was brought to recover damages for an injury received by plaintiff in having his arm caught between a pulley attached to the cylinder shaft of a threshing machine, such machine being exhibited at the La Crosse county fair in September, 1912. The platform upon which the machine stood was not properly guarded with a hand rail. In the trial court, a jury returned a verdict of $3500. The judge deemed such amount excessive and gave the plaintiff an option to take judgment for $2000 or a new trial. Judgment was entered for $2000 and the defendant Rumely Co. appealed. The Supreme Court affirmed the judgment. *(Pennell v. Rumely Products Co., 149 N. W. 769.)*

Injured by Gears

(Massachusetts.) In an action for injuries to a boy fourteen years old, whose fingers were caught in the gears of a machine, of the existence of which gears he did not know, when the cover enclosing the gears slipped off, evidence to the effect that his employer had not instructed him as to the dangerous character of the machine was held sufficient to warrant a jury in a finding of negligence in exposing plaintiff to a hidden peril in work that apparently was not dangerous, without instructions or warning. *(Moloney v. Pemberton Co., 107 N. E. 388.)*

Excessive Charge for Machinery

(Washington.) Where machinery had been manufactured upon defendant's order and accepted by the defendant, the manufacturer, in the absence of an agreement as to the price, can recover the reasonable value of the machinery, though he charged the defendant with a price in excess of the reasonable value.

Where defendants purchased certain machinery without any agreement as to the price, an instruction that, if the jury found that defendants could have purchased the machinery in the open market at a price considerably less than plaintiff asked, that fact might be considered in determining whether there was a contract between the plaintiff and defendants, was erroneous, misleading, and confusing. *(Nordeen Iron Works v. Rucker et al., 145 P. 219.)*

Conditional Sale of Machinery

(Georgia.) A purchaser of machinery in a conditional sale contract was adjudicated a bankrupt. In his schedule he listed this machinery as part of his assets. The seller of the machinery, in reclamation proceedings, obtained an order of court to repossess himself of the property. Later the seller brought suit against the sureties on the bankrupt's conditional sale note and obtained judgment. The machinery had not been removed from the bankrupt's premises. Under such circumstances it is only proper that the seller should not have the right to take possession of the machinery, since judgment had been secured against the sureties on the conditional sale note. *(Mallary Bros. Machinery Co. v. Thomas et al., 83 S. E. 783.)*

Assumption of Risk

(Maine.) A servant assumes the risks of dangers known to him, as well as those incident to his work and apparent to one of his intelligence, and is chargeable with knowledge of the things and conditions which he sees, or by the exercise of reasonable care ought to see, and his failure in that respect is negligence, and the master may assume that he will see and guard against apparent dangers. *(Monk v. Bangor Power Co., 92 A. 617.)*

Foreclosure of Chattel Mortgage

(North Dakota.) Where property is sold on the foreclosure of a usurious mortgage, one who purchases at the foreclosure sale and pays his money without notice of the usurious character of the mortgage is protected as a *bona fide* purchaser of the property, and the same is true where, after the foreclosure sale and before the expiration of the time of redemption, a person buys the interest or estate of the mortgagee who bids in the property at the sale. *(Heitsch et al. v. Minneapolis Threshing Machine Co. et al., 150 N. W. 457.)*

Master's Liability for Injury to Servant

(Federal.) Plaintiff for four years had operated a machine in defendant's shoe factory, above which was an electric light. She arrived one morning five minutes before time to commence work, when it was quite dark, and was unable to turn on her light, because the current had not been switched on from below, which was done, however, in two or three minutes. In the meantime she undertook to hang up her coat in the place provided, which required her to step upon a chair and from there on a bench, and in doing so she placed the chair on some shoe uppers which had been left on the floor by a fellow servant, and the chair tilting, she fell and was injured. Held that, in so far as there may have been negligence in so placing the coat hangers as to make it necessary to climb upon the bench, the risk was an obvious one, which she knew and assumed; that she also assumed the risk involved in moving around and placing the chair in the dark, which was not required by her employment or properly incident thereto. *(W. H. McElwain Co. v. Bullock, 217 Fed. 962.)*

* * *

An alleged new method for producing electricity commercially (?) consists in placing thermo-electric couples around heated flues. The thermo-electric elements are separated by a layer of mica insulation and are joined at their hot ends by a band of electrolytically deposited copper. Five of these elements are connected in a series to form a unit and a suitable number of units are formed into a ring that surrounds the heated flue. The unheated ends of the elements are kept cool by circulating cooled air around them. The cost of installing such a system, as compared with the cost of gas, oil and steam operated engines, is stated to be less than half, while the cost of producing electricity by this means is from one-third to one-fourth of the cost when produced by steam, gas or oil plants. Unfortunately it is not possible to go right ahead and install such a system, and thus save so great a percentage of the present cost of producing electricity, because the couples are composed of an element made of a *special secret alloy*. Experience teaches that when secret alloys or processes form part of a new development like the one mentioned, the most important secret of all is to gather in the proceeds from unsophisticated investors.

SNAPSHOTS ON THE ROAD

SOME NOTES PICKED UP AT RANDOM BY MACHINERY'S FIELD SERVICE EDITORS

—"there are hardly enough patterns to warrant the employment of a stock-keeper and a regular system for keeping track of the patterns."

THE simplicity of an idea is often its saving point. There is a small concern right in New York City that has a set of patterns almost in constant use. As yet there are only about two hundred patterns in all, but to lay your hand on any one of them is a hard job, because there are so many places where they might be. For instance, there are two different brass foundries and two iron foundries patronized by this concern, all located at a considerable distance from the shop, and the pattern may be at any one of these; or it may be in the storage or in the pattern-room. The difficulty is that there are hardly enough patterns to warrant the employment of a stock-keeper and a regular system for keeping track of the patterns, but there are too many to depend on memory alone.

The superintendent of this little concern, however, is a common-sense sort of a chap, and the way he handles the matter is as follows: He had the patternmakers saw out two hundred wooden cubes, ¾ inch square. He painted the faces of the cubes different colors and then made a special box to hold them all in one layer. On the cover of the box he inscribed "tracers" for the different colors; thus, red meant that the pattern was in one of the iron foundries, blue that it was in one of the brass foundries, and so on. The faces of the cubes were all numbered (over the color) with a pattern number, and the cubes were then arranged in numerical order in the box. Now, when a pattern goes to any of the foundries or to the pattern-room, the cube is turned with the color corresponding with that location uppermost. Thus, at a glance, the superintendent can tell from the color of the cube face that is turned up just where the pattern is.

Down in the Nutmeg state, a little while ago, the traveling editor went into a shop where the man in charge had difficulty in punching a lug from thick stock, raising it from the opposite side of the metal. The trouble was that in obtaining sharp sides on the lug, the metal was sheared and weakened. Now it happened that the traveling editor had seen a similar job done in a shop in New York state, so he sat down, and on the back of an old time-card, made a sketch of a die that would do the trick without weakening the lug. The idea consisted in driving the stock down around the lug, leaving the metal in the lug in its original condition while the rest of the metal was depressed. Simple—sure it was simple—but the man who had trouble certainly was glad to receive the suggestion, as it saved the day; and the next time the traveling editor visited the shop he had the pleasure of seeing the tools in operation. It is not far from the truth to say that the owner of this little shop appreciates a mechanical visitor when he sees him.

It is not always in the shop that a suggestion from a visitor is most appreciated, but oftentimes it is the man who is trying to sell the product of the machine shop who is looking for tips. One of the most frequent calls for assistance is from the head of the young concern which is just starting to market its product. He usually knows a great deal about the product, but little or nothing about publicity or circularizing. What troubles him most of all is to get a good mailing list. He has been asked to buy all kinds of mailing lists, but he does not know their value; sometimes they are valueless. The best mailing lists, like the best of all other things, are made by hard digging, taking the names from here, there and everywhere—from trade journals, directories, correspondence, talks with salesmen, etc. After the list is started, constant pruning and revising is necessary to keep it up-to-date, and constant adding is required to make it complete.

"He has been asked to buy all kinds of mailing lists."

—"on the proprietor's desk there was just room enough to squeeze in the telephone after pushing back correspondence of the past decade."

Keeping the sales and engineering forces and department foremen in touch with the developments in their field is handled in a very satisfactory manner by a large manufacturing concern in New England. As soon as a technical magazine comes into the office, it is turned over to the publicity department and carefully looked over, and the articles pertaining to the subjects that are of interest to the manufacturing plant are marked. Typewritten copies are then made out, giving the title of the article, the contributor, the name of the magazine and the date of publication. These lists are compiled each month, and are distributed as follows: sales department, engineering department, salesmen on the road, advertising department, and department foremen. As soon as these lists are placed in the hands of the various men receiving them, they are quickly gone over, and the article that the man is interested in is marked. This insures him that a copy of the magazine containing this article will be furnished from the library. He reads the article, and the magazine is returned. It might be mentioned that several copies of each magazine are kept in the library, so that there is little, if any, difficulty in meeting the demand when more than one man is interested in any particular subject. This method has the advantage of keeping the responsible men informed on what is going on in their particular field without the necessity of looking over a great many technical publications, etc.

Recently the traveling editor went into a little shop in a Massachusetts town in the dusk of a winter's afternoon. He found the oil-soaked stairway pitch-dark, the box-like office littered with pieces of scrap steel and other junk, and on the proprietor's desk there was just room enough to squeeze in the telephone after pushing back correspondence of the past decade. The trained mechanic does not have to spend an hour in consultation with a shop superintendent to find out if things are up-to-date or not. He gets to be a sort of Sherlock Holmes on such matters, and when he finds a tumbled down plant, a worn-out sign, a disorderly office and a dark and dingy shop, he knows that it is not often that the work done there is up-to-date. So, he knew at once that there was not much hope of seeing any-

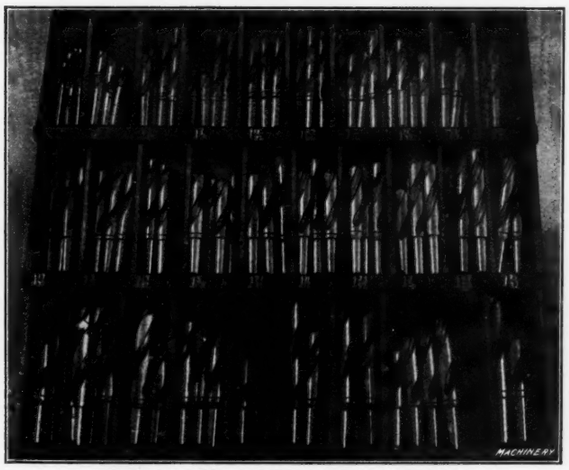
thing of particular mechanical interest in this place.

And the proprietor backed up his conclusion. He was of the old school and had built up a small business by working fourteen hours a day and cutting prices down to the last mill. "No, I will not consider having any of our ideas published, because I want to keep them right under my hat. What is the use of giving to the other fellow what you have worked hard to find out yourself?" he replied, when the subject of publicity was broached to him; but this fellow was ready to reap the benefit of mechanical information published by others just the same. "Say, you fellows published a table showing just how far to set a circular forming tool above or below center, didn't you? If you did, I wish you would send me a copy." Then came the psychological moment for preaching a sermon of publicity to this man, and he got it, too. But, after all, fear of publicity is a state of mind, and you can't cure it by arguments.

* * *

VERTICAL DRILL RACK FOR STOCKROOM USE

Many machine shop stockrooms use the same style of rack for holding drills, reamers, taps, etc. This is often in the form of a drawer or horizontal rack with pockets or partitions for the different sizes of drills. As, however, one of the points a workman considers in picking out a drill is its



Rack for holding Drills in Vertical Position

length, the horizontal method of storing is not conducive to picking out a long or short drill quickly.

The Watson-Stillman Co. of Aldene, N. J., employs a very simple modification of the drill rack that overcomes this drawback. The illustration shows the Watson-Stillman drill rack which is placed in an inclined position slightly away from the vertical. Thus all the drills are supported by their ends, and the long ones or short ones are readily picked out. In addition, the points of the drills may be more easily inspected than when lying in a horizontal position.

C. L. L.

* * *

GOVERNMENT INSURANCE RATES ON FOREIGN SHIPMENTS

Many inquiries have been received at Washington as to the rates charged by the Bureau of War Risk Insurance, Treasury Department, Washington, D. C., on shipments to foreign countries. The department, therefore, publishes the following schedule of charges now in force for freight shipments, the insurance, of course, being confined to vessels under American registry.

1. Rates from any ports in the United States to any port in the United States or its possessions, or to any non-belligerent port in the western hemisphere, ¼ per cent.

2. Between ports on the west coast of the United States and Japan or China, ¼ per cent.

3. To any non-belligerent port other than those included in paragraph 1, and not north of Havre, nor east of Sicily, ½ per cent.

4. To all other ports, ¾ per cent.

HOW THE CHISEL POINT OF A DRILL WEARS*

BY R. POLIAKOFF†

The results of experiments conducted by the writer show that the chisel point of a twist drill exerts a considerable influence on the work done by the tool, as it increases the end thrust by about 20 per cent. The illustrations Figs. 4 to 12

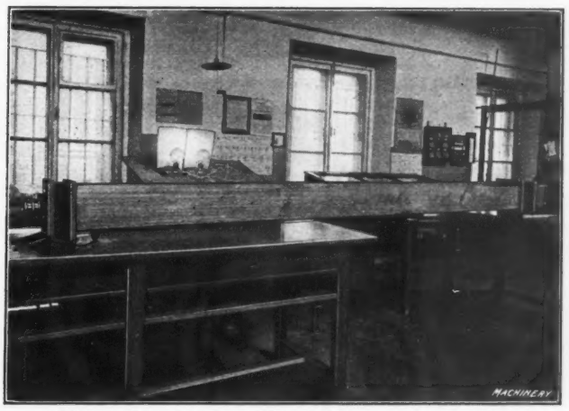


Fig. 1. General Arrangement of Camera used for taking the Photographs

give a good idea of how the chisel point gradually wears away until the drill becomes so blunt that it is unable to cut. These photographs show a one-inch high-speed steel twist drill made in England. The material in which the drill worked during the test was a steel block containing 0.45 per cent carbon, with a hardness number of 138 as determined by the Shore scleroscope.

Before starting the experiments proper, a few preliminary tests were made in order to determine the maximum cutting

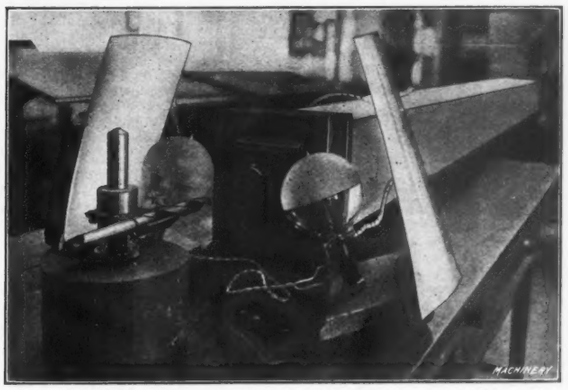


Fig. 2. Method of supporting Drill and securing Required Illumination

speed which could be used without burning the cutting edges of the drill. This was found to be about 50 feet per minute, and was adhered to as closely as possible in the subsequent experiments. The feed employed was 1/72 inch per revolution of the spindle. The drill was run for fifteen seconds at a cutting speed of 14 feet per minute, after which it was taken out and photographed. After making the photograph, the drill

Fig. 3. Chisel Point of Drill to be tested

* For further information on this subject see also "Experiments on Twist Drills," published in MACHINERY for May and June, 1909.

† Address: Imperial Technical Institute, Moscow, Russia.

was started again and run at the established cutting speed of 50 feet per minute for ten seconds, after which it was re-photographed, this procedure being continued at ten-second intervals, as long as the drill was able to cut. In order to show as clearly as possible how the chisel point of the drill wears, photographs were taken in such a way that the point of the drill is shown magnified to twenty-five times its actual size. For this purpose, the camera was arranged as shown in Figs. 1 and 2, the apparatus consisting of an ordinary camera attached to a long light-proof square tube made of wood and painted black on the inside. Two electric lamps were installed at each side of the drill.

Fig. 3 shows the chisel point of a fresh drill and Figs. 4 to 12 show the gradual deterioration of the chisel point. These illustrations are of value in showing the increasing influence of the chisel point on the magnitude of the end thrust of the drill, when it is considered that the speed at which the drill was driven did not result in burning the cutting edges. Experiments have also shown that the drill can work on the class of material on which the tests were made, without requiring regrinding, until it has been at work for about thirteen minutes, this figure being based upon a speed of 50 feet per minute for the cutting edges of the drill. Operating under these conditions, the drill will have cut through about 18 inches of metal and consumed about 6.3 horsepower.

* * *

At the beginning of the war it was feared that the effect would be disastrous to the industries in Austria, but at the present time many branches of trade have revived. Of course, factories of arms and ammunition and of all supplies necessary for warfare have been working with feverish energy to provide the armies in the field with supplies. This includes both government works and private firms. The shoe factories, which before the war were running on short time, have doubled their output. Wood-working machines are in demand, as the building of barracks and other military constructions has given new life to the lumber trade. Manufacturers of railway material are building new rolling stock, apparently to replace much of that which has been destroyed or rendered useless by the war. In industries which do not in any way cater to the demands furnished by the war, conditions, of course, are not flourishing.

Fig. 4. Time, 15 Seconds; Depth drilled, 1/10 Inch; Speed, 14 Feet per Minute

Fig. 5. Time, 25 Seconds; Depth drilled, ¾ Inch; Speed, 50 Feet per Minute

Fig. 6. Time, 35 Seconds; Depth drilled, 1 Inch; Speed, 50 Feet per Minute

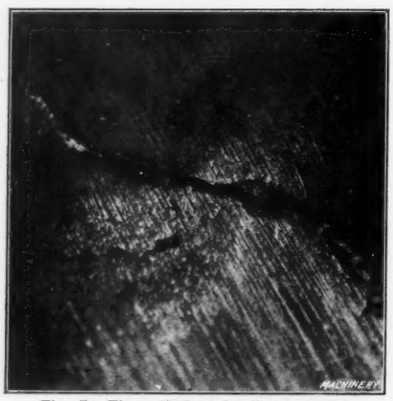


Fig. 7. Time, 45 Seconds; Depth drilled, 1¼ Inch; Speed, 50 Feet per Minute

Fig. 8. Time, 55 Seconds; Depth drilled, 1½ Inch; Speed, 50 Feet per Minute

Fig. 9. Time, 65 Seconds; Depth drilled, 1⅞ Inch; Speed, 50 Feet per Minute

Fig. 10. Time, 75 Seconds; Depth drilled, 2 3/16 Inches; Speed, 48 Feet per Minute

Fig. 11. Time, 85 Seconds; Depth drilled, 2⅛ Inches; Speed, 48 Feet per Minute

Fig. 12. Time, 95 Seconds; Depth drilled, 2¾ Inches; Speed, 48 Feet per Minute

SOME TYPES OF AUTOMOBILE CRANKSHAFT LATHES

BY J. C. SPENCE*

In the January number of MACHINERY, W. O. Strauss, under the title "Some Types of Automobile Crankshaft Lathes," states that "the economy of rough-turning crankpins preparatory to finish-grinding, as compared with rough-grinding, has been so thoroughly determined in the highly specialized shops that it needs but small mention here as a competitive proposition." This statement is rather a surprising one to those of us who have been connected with the grinding of crankshafts for the last ten years. To be sure, Mr. Strauss does not say that he refers to the automobile business, except in his title; but from the size of the crankshaft lathe described by him, the inference is that he is talking about that industry. If he had in mind the making of crankshafts for battleships or punch presses, then his statement would hold true, but on all crankshafts whose pins are not over 5 inches in length and whose webs do not need to be machined, exactly the opposite is true. The evidence of this does not, however, lie in theoretical study which worries about "the probable line of fracture" of the wheel, but in the fact that at least 85 per cent of all of the automobile crankshafts made annually in the United States are ground from the rough forging. The following is a partial list of firms who use the grinding method: Ford Motor Co., Willys-Overland Co., Buick Motor Co., Reo Motor Co., Mitchel Automobile Co., Hupp Co., Maxwell Motor Co., Dodge Bros. Co., J. I. Case Automobile Co., and Garford Automobile Co. In addition to the above, there are many jobbers and motor manufacturing firms who make crankshafts for sale, by the grinding method. It will be noted that those manufacturers who are producing a moderate priced car, and who are compelled by competition to produce good cars at a low labor cost, are the ones who have decided in favor of grinding crankshafts from the rough. The mechanics at these plants are hard-headed men and do not settle such important questions by theory. Rest assured that each one of them knows the gross cost of his particular crankshaft when made by both methods. The makers of grinding machines have been remarkably sane and conservative in this matter and have been very careful not to recommend grinding where experience tells that the lathe is better. Without question the lathe is better when the webs have to be machined for connecting-rod clearance, and whenever the end thrust collars of the pins or bearings are very deep beyond the fillet. A careful record of the manufacture of 12,000 crankshafts of various types in one season showed us that the wheels used per shaft, including all of the grinding on a shaft and not the pins alone, cost 4 cents per shaft; and that all of the diamonds worn out and lost cost 5 cents per shaft. This allowance is liberal, as some of the wheels and diamonds were also used on work of which no record was made. It will be seen from this that the grinding method has to save just 9 cents per shaft, or nine minutes, if time is rated at 60 cents per hour.

Up to date this has been an easy problem, especially when investigation of the crankshaft lathe reveals the fact that in every case, so far observed, the practice has been to leave from 1/16 to 1/8 inch on the diameter of each rough-turned pin, in order to insure all of the pins finally "cleaning." This large amount of stock, in most cases, calls for a rough-grinding operation anyway, and hence the lathe proves to be a hindrance rather than a help, as the rough-turning plus the rough-grinding costs more than if all the stock had been removed by grinding. This large amount of stock left by the turning operation is due to two causes: 1. A lathe tool releases all forging strains at one cut, whereas a grinding wheel releases them gradually and constantly corrects the error. 2. The heads of the lathe attachment get out of line and are not given the same care as is a grinding machine, simply because everybody has it in mind that the operation is a rough one anyway. At any rate, brushing the theory of drafting-rooms to one side, the fact remains that very few, if any, firms are turning crankshafts good enough to call for finish-grinding only.

* Address: Care of Norton Grinding Co., Worcester, Mass.

Following the same article we read that "The rapid disintegration of the coarse grained wheel from contact with the fins left from the forging dies, and the necessity of frequent redressing to maintain fillets, is a big factor from the standpoint of wheel up-keep, besides causing frequent delays in the production chain." It may be of interest to know that, in at least one make of grinding machines, a 24 by 2 by 5 inch hole wheel will rough-grind 2000 pins 2 inches long by 1⅝ inch in diameter, removing 5/16 inch of stock from the diameter, and then the wheel will be 14 by 2 by 5 inches in size and can be used up on other work. If the machine is light, of course the wheel suffers, and in some makes of machines only about 1000 pins can be obtained per wheel. The right wheel on the right machine does not "disintegrate" any more than high-speed steel disintegrates. The grains wear out in doing useful work. The micro-photograph has proved this to the satisfaction of investigators. Now concerning the bugaboo of wheel "dressing," it seems too bad, at this late date, to have to say again that wheel "dressing" is a blessing and not a curse. Wheel dressing invariably increases output, just as frequent sharpening of lathe tools increases output. If you can increase output and reduce cost by throwing away abrasive grains, then you should be willing to throw them away.

* * *

INTERNATIONAL ENGINEERING CONGRESS

The success of the International Engineering Congress to be held in San Francisco, Cal., September 20-25, is now well assured. Notwithstanding the difficulties arising as a result of the European war, the committee on papers is able to count on from two hundred to two hundred and fifty papers and reports, covering all phases of engineering work and contributed by authors representing eighteen different countries. Although the representation from the countries involved in the European war will be less than originally planned, the congress will still be truly international. The papers are now rapidly coming in and their character gives the fullest assurance that the proceedings will form a most important collection of engineering data, and a broad and detailed review of the progress of engineering art. Membership in the International Engineering Congress, with the privilege of purchasing any or all of the volumes of the proceedings, is open to all interested in engineering work. Further particulars relating to the congress may be obtained from the secretary, W. A. Cattell, 417 Foxcroft Bldg., San Francisco, Cal.

* * *

TOLERANCES IN SCREW THREAD FITS

The Committee on Tolerances in Screw Thread Fits appointed by the American Society of Mechanical Engineers, of which L. D. Burlingame of the Brown & Sharpe Mfg. Co., Providence, R. I., is chairman, called a meeting at the Engineering Societies Building, in New York, February 5. At this meeting were present about forty men representing the tap and die industries, the screw-making industries, and the users of taps and screws. A number of valuable suggestions were given to the committee by the representatives of the various interests present, and it is believed that these suggestions will greatly aid the committee in formulating definite standards for screw thread tolerances. In a general way, the opinion was expressed that all taps should be above standard size, while all screws should be below standard size. The actual limits that would be necessary would vary in different industries, and the committee is inclined to believe that it will be necessary to establish a number of standards to apply (1) to ordinary commercial work; (2) to precision work; and (3) to work of a character that permits of greater limits than the general type of commercial work.

* * *

A British patent has recently been taken out covering a new composition for maintaining the brightness of polished steel parts. The ingredients contained are heavy white paraffine, starch and alum. The starch and alum are thoroughly mixed and the water evaporated from them, after which the compound is mixed with paraffine at about 110 degrees F.

EYE PROTECTION FOR GRINDERS AND MACHINISTS

BY H. W. DAVIE*

There are more risks of injuries to eyes in iron and steel plants than to any other single part of the body. The Pullman Co.'s accident charts show that 35 per cent of all injuries are eye injuries. Dust, flying particles, sparks and glare, unless guarded against by efficient eye protectors, offer constant and unavoidable danger to the men. This fact is being recognized by safety engineers, liability companies and industrial commissions in various states. Leading liability

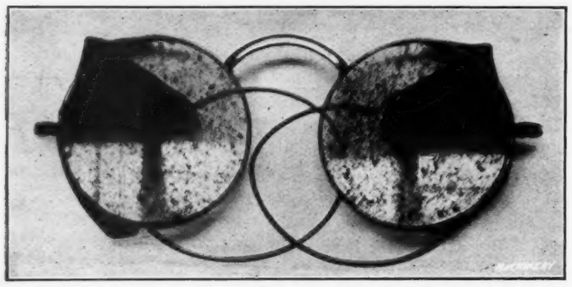


Fig. 1. Glasses after having been used Two Weeks by a Grinder

companies are requesting, and in some cases requiring, their subscribers to provide adequate protection for the eyes of their men. State officers are beginning to realize their responsibility in this matter and are issuing safety booklets describing dangers of accidents and recommending suitable safeguards for their prevention. This is notably so in California, Illinois, Iowa, Kansas, Massachusetts, Minnesota, New Jersey, New York, Ohio, Pennsylvania, Washington and Wisconsin.

Many employers have sought to provide their men with eye protectors and have met with more or less prejudice on the part of the workmen. Many of the workmen believed that glasses would injure their eyes or that they could see better without them, and they have gone on squinting at their work, receiving more or less serious injuries to their eyes, and when actually supplied with eye protectors they have tucked them under their benches and gone on as before. A good deal of this is due to the often-met prejudice against anything new. Another cause is that the eye protectors are sometimes so uncomfortable and irritating as to render their constant use impossible. Those objections have been overcome, however, and improvements have been designed which yield perfect comfort as well as complete protection to the wearer. When improved eye protectors are demonstrated to the workmen and the great value of safety glasses is shown, they wear them gladly and constantly. A great deal of patient explanation is necessary to induce the men to try them, but once fairly tried they are fixtures. But it is not only the men who have to be shown the benefits of eye protection. Many foremen do not realize that the numberless minor accidents to men's eyes, causing not only the injured person to stop work to get grit, dust or other particles out of his eye, but a mate to help him, and perhaps one or two others to look on, may all be avoided by the provision of suitable safety goggles.

"Small particles are likely to become lodged in the cornea of a workman's eye. Close examination with a magnifying glass will usually show large numbers of minute scars, sometimes so numerous as to dull the cornea and affect the vision," says Dr. Mark D. Stevenson. In a grinding room there are countless injuries to men's eyes which are, in many cases, given little consideration at the time. With so much fine dust and grit flying about many particles imbed themselves in the cornea of the eye. When these particles are rather large they cause such immediate irritation that the grinder leaves his work and calls on the "shop doctor" or some fellow worker to get it out. This, of course, is a very dangerous procedure. The man's eyes may become infected from the use of a dirty toothpick or handkerchief, or the implement used may scratch the surface of the cornea so as to injure it permanently. Sometimes these particles may seem to have been taken out and, as in the case of the fine particles and dust which do not cause immediate irritation, they imbed themselves in the cornea so as to ultimately dull the vision and seriously affect the man's efficiency.

This matter has, up to the last year or two, been given little consideration generally and few people have realized how vitally necessary the protection of a grinder's eyes is. Without eye protectors he must squint and thus reduce his efficiency, and if he gets emery grit or bits of hot metal in his eye he will lose from five to twenty minutes in getting it out, if it is not bad, and if it is bad, he may lose days and weeks and ultimately his sight. With all of the fine dust flying about a grinding room where there are numbers of men working, protection at the side is just as important as protection at the front.

"Since the particles cut off by wheels are comparatively small, a heavy type of goggle is unnecessary. Goggles should have side guards of wire or leather as particles coming from the side frequently enter the eye," said R. G. Williams before the National Machine Tool Builders' convention at Worcester. It is readily seen that when there are a number of grinders working in a row it is impossible to prevent the sparks from one grinding wheel flying into another grinder's eyes. After most exhaustive tests as to the best way of protecting grinders' eyes, it has been proved beyond doubt that side guards should be provided on the glasses.

A man grinding high carbon or manganese steel looks constantly into a steady stream of sparks, the glare of which may cause *retinal asthenopia.* Retinal asthenopia is a condition from which the eye usually recovers after a suitable period of rest, but the loss of sight may be more lasting as the result of prolonged exposure to intense glare. In the industrial world retinal asthenopia is a dangerous condition, partly because of the insidious way in which it works.

A man grinding manganese or high-carbon steel should be protected from the harmful glare as well as from grit and dust. The desirability of light amber colored lenses for grinders' glasses has been proved in the research laboratories of one of the largest manufacturers of grinding wheels in the world. Grinders to whom glasses with white lenses have

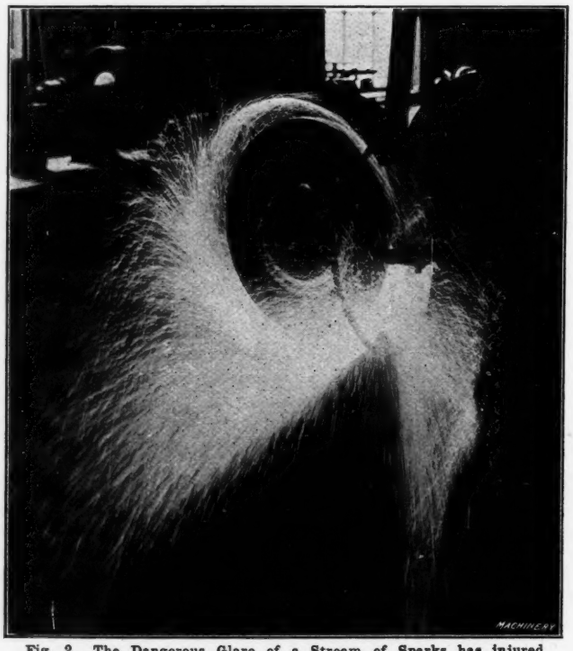


Fig. 2. The Dangerous Glare of a Stream of Sparks has injured Many a Worker's Eyes

been given have complained of strain and irritation of the eye and blamed the glasses. The strain existed before, but was not noticed until something new brought it out. At once amber lenses were provided to cut out the harmful rays. There is an anti-sweat pencil on the market which will obviate sweating of the lenses. The effect of this pencil will last for from four to five hours.

* Address: T A. Willson & Co., Inc., Reading, Pa.

It is highly important that a heavy chippers' glass should not be given to grinders, machinists and others who do light work and who do not need such heavy protection. They will naturally object to the extra weight, and to get the maximum cooperation from workmen it is only wise to do away with all possible objections. Another thing which should be given careful attention is the matter of workmen who wear correction glasses. If these lenses are unprotected they quickly become scarred by emery grit and are soon so covered with spots that they are of little use. In the past it has been a frequent sight to see workmen wearing cheap leather goggles (such as are bought in 5 and 10 cent stores) over their regular glasses. Now, when the importance of good quality glasses is recognized by safety experts, eye protectors should be provided which can be worn over correction lenses even more easily than the old-style leather dust goggle. It seems unfair to burden a workman with placing high-priced correction lenses in his safety glasses and then having him pay for the many repairs which necessarily follow. In a good sanitary grinders' goggle which can be worn over other glasses and still provide protection from all angles, the workmen receive perfect protection and the cost of extra lenses for the eye protectors is small.

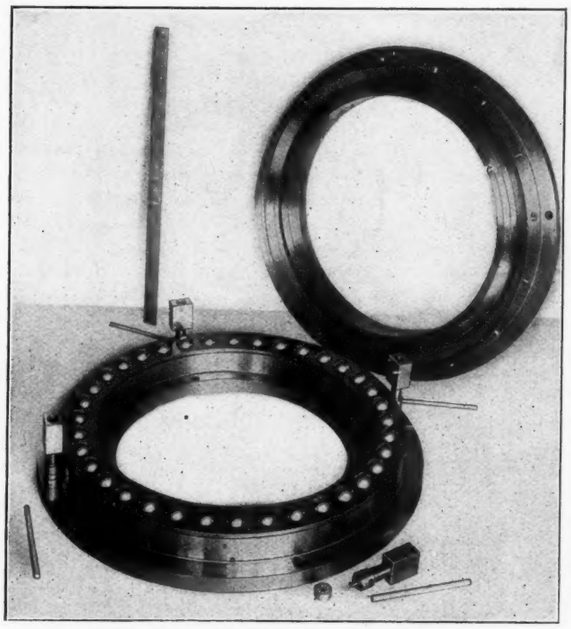


Fig. 1. Large Thrust Bearing for Lighthouse Use

It is surprising to note the number of foundries in which no protection is given to the eyes of such workers as molders, pourers, grinders, men slagging the cupola, etc. The idea that these dangers were "risks of the trade" has been so strong that neither employers nor employes awoke to the fact that not only can much pain and impairment of sight be avoided, but the efficiency of the workmen can be increased and much time and money saved for the employers.

Under the new workmen's compensation laws, employers are required to furnish certain safeguards, but there is nothing to require the men to wear them. After showing the men the advantages of eye protectors, corporations should absolutely require them to wear the glasses for mutual benefit. In some cases the management purchases supplies of eye protectors for different needs and sells them to the men at cost, while other plants distribute them to the men free of charge, recognizing that it is but a slight expense compared to the liability incurred if eye protectors are not worn. Since laws and insurance requirements force employers to furnish eye protectors where needed, it is but right that the employer should require his men to make actual use of them. This is an easy matter when they are shown the advantages.

* * *

A BALL BEARING FOR LIGHTHOUSE USE

The Auburn Ball Bearing Co., Rochester, N. Y., recently made a number of large ball bearings for use in government lighthouses to support the revolving lenses and mountings. One of these bearings is illustrated in Fig. 1, and this particular one was made for the Jupiter Inlet Light Station in Florida. From the illustration it will be seen that the bearing is of unusually large diameter and its general dimensions may be estimated by the two-foot rule shown beside it. The external diameter of the bearing is 24¾ inches and the 1¼-inch balls are spaced around a 20-inch circle.

The weight of the lens and mounting is only about 2000 pounds, although a bearing of this size is capable of carrying ten times that load. The timing of the "flashes" from a lighthouse must be uniformly constant year after year, in order that steamers at sea may always be able to identify the lighthouse from the duration of the flash and the interval between its flashes, and thus get their location. These intervals are often in seconds, so it is vitally important that no variation whatever occur. It is therefore necessary to reduce variations in frictional resistance to a minimum. Moreover, the driving mechanism for revolving the lenses is very delicate and of small power, so that by making the bearing of such large carrying capacity it is intended that the change in shape of the race grooves or balls from many years' use will be so slight as to practically make no perceptible difference in the driving resistance.

The details of the bearing are shown in Fig. 2. The ball races measure 22½ inches external diameter with an internal diameter of 17½ inches. These, of course, are of the best tool steel, hardened, accurately ground and highly finished. The race grooves are of the four-point cone principle which the Auburn Ball Bearing Co. employs on all its bearings. The balls are of hardened tool steel ground and polished to 0.0001 inch of size, and, as before stated, are 1¼ inch in diameter. The ball races are mounted in cast-iron flanges, being fitted in turned recesses. A ball separator 5/16 inch thick is placed between the two ball races to keep the balls equally spaced. A dust protector in the form of a metal ring is screwed to the upper ball race and extends down over the opening between the two races, effectually keeping dust and dirt from the bearing.

An interesting feature of these bearings, and one quite unusual, is the provision for raising the load so that the balls and races may be cleaned. Smooth running action was the principal feature to be desired in this bearing, and to insure this frequent cleaning is necessary. To raise the load from the balls and lower race four jacks are employed, being placed around the bearings equidistantly between the outer flanges. These are ball-bearing jacks, as may be seen from Fig. 1, and small pins are employed to turn them and raise the upper race clear of its contact with the balls. To put the bearing in commission after cleaning, it is only necessary to turn down the jacks until they are clear of the upper race, when the bearing again takes up the load.

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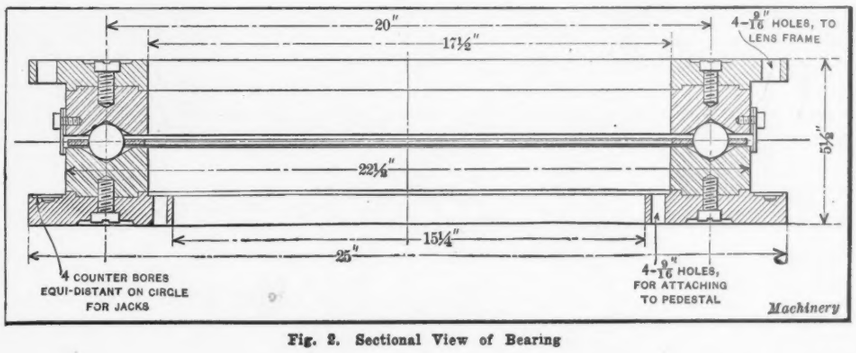


Fig. 2. Sectional View of Bearing

MACHINING SHRAPNEL SHELLS*

TOOL EQUIPMENT USED ON THE POTTER & JOHNSTON AUTOMATIC CHUCKING AND TURNING MACHINE

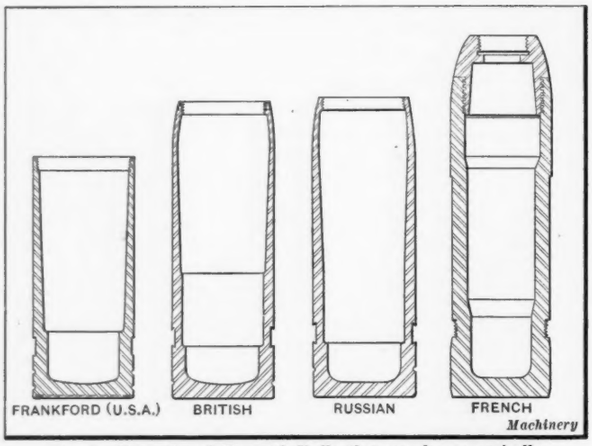


Fig. 1. Examples of Shrapnel Shells that can be economically machined on Potter & Johnston Automatic Chucking and Turning Machines

WITHIN the last few months the manufacture of shrapnel has become a great industry. There are at present a large number of firms engaged in this work and the number is constantly increasing. The ingenuity displayed by machine tool builders in adapting their machines to the requirements of this work is worthy of special notice. The shrapnel shells used by some of the principal governments vary slightly in construction, as is shown in Fig. 1, and consequently require slightly different tooling equipments. The principles involved in the machining of the different shells, however, are practically the same. The following article will describe the methods of manufacture followed in producing British shrapnel shells on the Potter & Johnston manufacturing automatic chucking and turning machine. Some of the tool equipment used for this work is unique and should, at the present time, be of special interest to manufacturers of shrapnel.

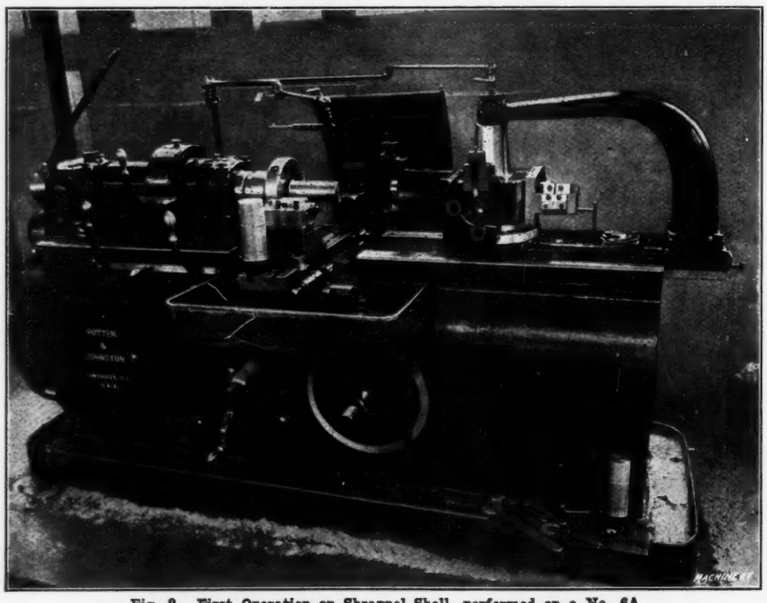


Fig. 2. First Operation on Shrapnel Shell, performed on a No. 6A Potter & Johnston Automatic Chucking and Turning Machine

Preliminary Operations in Producing a Shrapnel

Shrapnel shells are being produced from both bar stock and forgings, but it has been found that the forged shell is much superior to the bar shell because it is more homogeneous. It is therefore anticipated that, in the future, practically all shrapnel will be made from forgings instead of bar stock. In the making of forgings for shrapnel shells, the hydraulic press is used almost exclusively. In fact, until within the last few months this was the only method of manufacture. At the present time, however, power forging machines are being developed for this work. A shrapnel forging has its beginning in a rough billet, which is gradually forced into shape under hydraulic pressure and then finished in a draw-bench.

As this article, however, is to deal with the machining of shrapnel and not the making of forgings, we will confine the description to the manufacturing steps after the forging has been completed. While the Potter & Johnston automatic chucking and turning machine is especially adapted to the production of all the different types of shrapnel shells and cases, this article will apply only to the machining of the British forged shrapnel shell.

Machining the British Forged Shell on Potter & Johnston Automatics

In making the British forged shell on the Potter & Johnston automatic chucking and turning machine, three operations complete the work. The first operation completes the outside of the shell, except for the extreme end which is covered by the gripping mechanism of the chuck. The second operation finishes the inside of the shell and at the same time finishturns the extreme open end. After the second operation is performed the shell is "nosed in," which consists in heating it in a lead bath and then striking it under a light press to close in the end. The third operation then follows, and consists in taking light cuts from the inside and outside diameters and threading the open ends.

Method of Holding Shell for First Operation

For the first operation, the shell is held on an expanding arbor of the type shown in Fig. 4. The arbor *A* is tapered on its rear end and is held in the nose of the spindle of the machine. The shell is pushed onto this arbor until the end of the arbor strikes the bottom of the shell. The gripping mechanism which comprises six jaws *B* and a draw-in plunger *C* are contained inside the arbor. The external diameter of the arbor is machined to practically the same shape as the internal diameter of the shell, but is smaller. The jaws are held in slots which control their movement in every direction except radially. They are forced out radially by means of the draw-in bar *C* which is provided with tapered seats that engage the inward end of

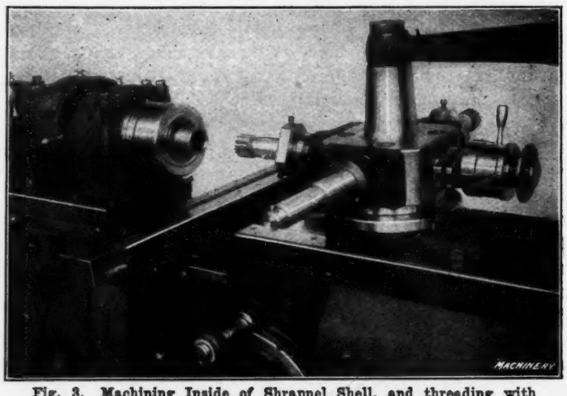


Fig. 3. Machining Inside of Shrapnel Shell, and threading with Automatic Collapsing Tap on Potter & Johnston Automatic Chucking and Turning Machine

* For additional information on shrapnel making, see "Making Shrapnel Cases on the Cleveland Automatic," February, 1914, and "An Interesting Job on the Gridley Automatic Turret Lathe," April, 1912.

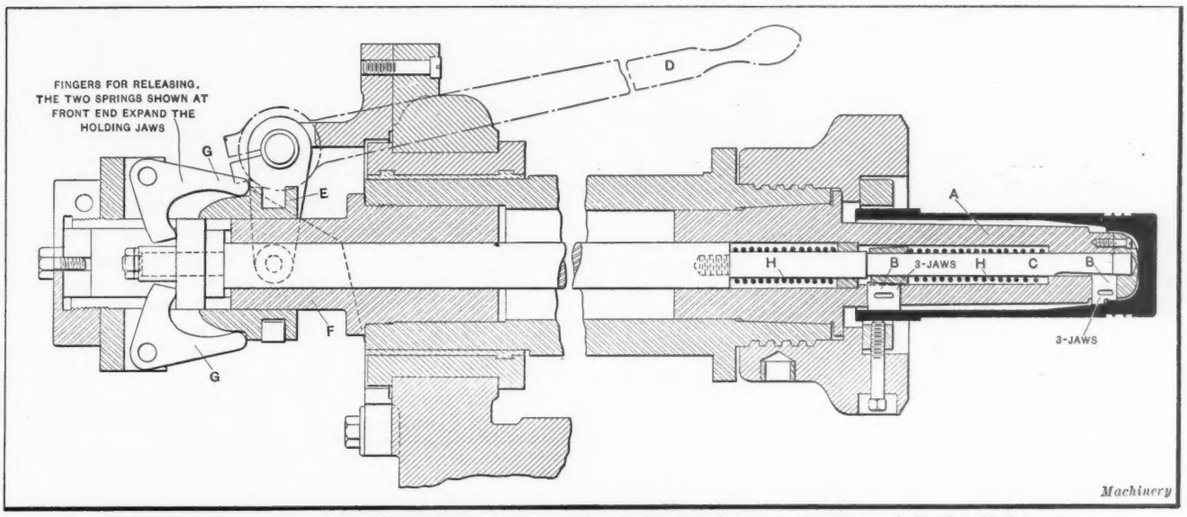


Fig. 4. Expanding Arbor and Chucking Mechanism used on Potter & Johnston Automatic Chucking and Turning Machines for performing First Operation on Forged Shrapnel Shells

the jaws. The bar *C* is operated by a hand lever *D* that extends up over the top of the machine, is fulcrumed in a bracket on the rear bearing cap, and is connected to a sliding sleeve *E*.

In clamping the work on the arbor, lever *D* is lifted up, this action drawing the sliding collar *E* to the right along the sleeve *F*, which, in turn, allows the forward end of the fingers *G* to close in. This releases the pressure of the outer end of the fingers on the draw-in bar *C*. When the pressure from bar *C* is released by means of handle *D*, heavy coil springs *H* then come into action forcing the draw-in bar back and expanding the clamping jaws. Additional clamping means is provided by three set-screws which are brought to bear on the work after it has been clamped in position by the jaws. To release the work, the reverse action takes place, that is, lever *D* is forced down which slides the collar *E* to the left, operating the fingers *G*, which, in turn, overcome the pressure of the springs *H*, allowing the clamping jaws *B* to collapse.

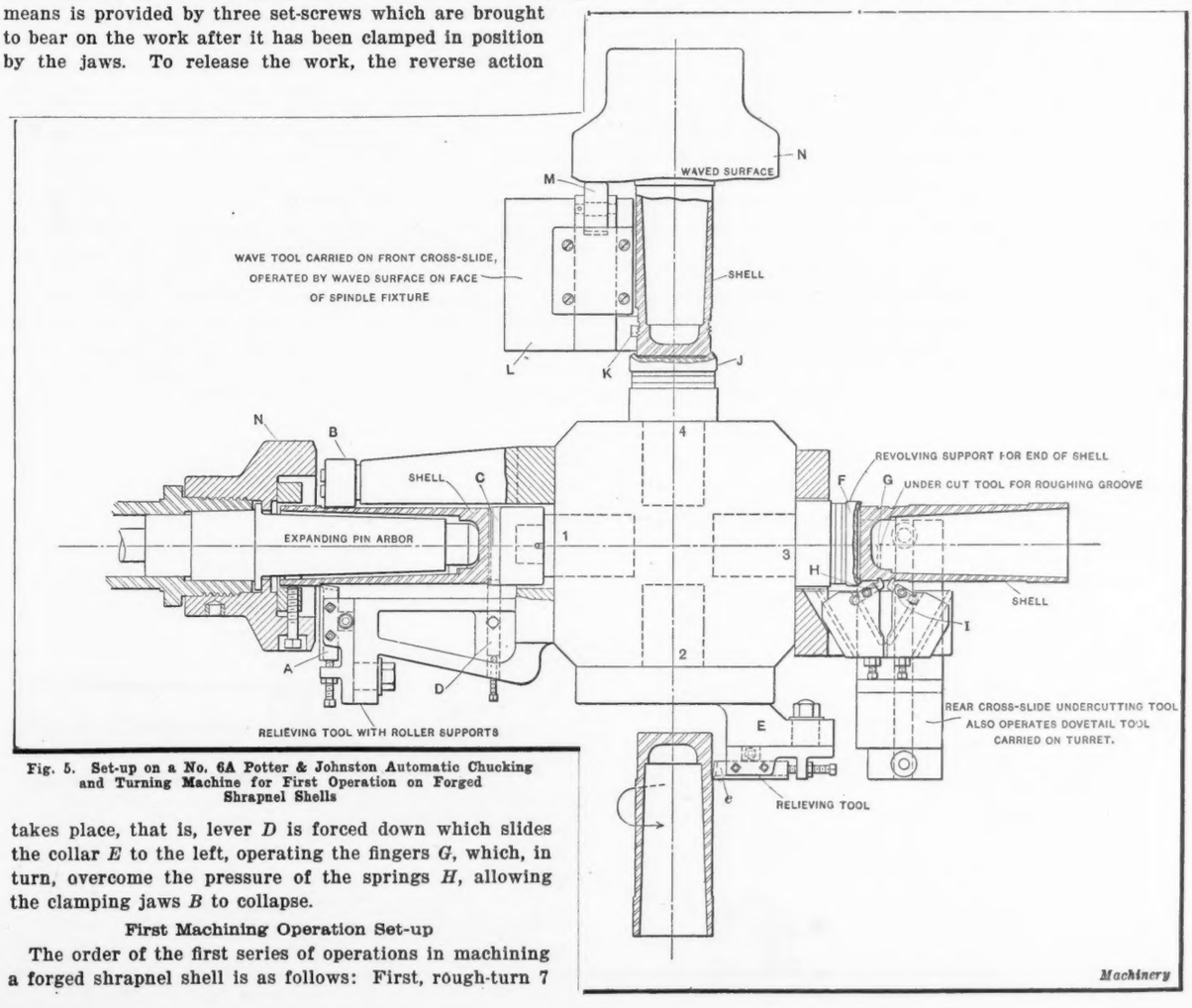


Fig. 5. Set-up on a No. 6A Potter & Johnston Automatic Chucking and Turning Machine for First Operation on Forged Shrapnel Shells

First Machining Operation Set-up

The order of the first series of operations in machining a forged shrapnel shell is as follows: First, rough-turn 7 inches along body of shell, face end and chamfer; second, finish-turn 2½ inches along shell; third, rough-groove for copper band and dovetail; fourth, turn waves in groove.

For the first operation, the work is held on the expanding arbor shown in Fig. 4, and the tool equipment, which is of an unusually interesting character, is shown in Fig. 5. The first rough-turning operation, accomplished by turret tool *A*, which is of the relieving type to be described later, is held on the first face of the turret and roughs down the body of the shell. On the opposite side of the holder is a roller support *B* which supports the shell while the turning tool is in operation. The end of the shell is faced by means of a facing tool

C which is really a type of facing mill. The end of the shell is then chamfered by means of a chamfering tool *D* that removes the sharp corner.

After these operations have been performed, the turret is indexed and the second face of the turret is brought in line with the chuck. This operation is accomplished with a relieving tool-holder *E* carrying a cutter *e*, which takes a cut 2½ inches along the body of the shell. An interesting feature of this tool is that on the return stroke of the turret it swivels back out of the way so that the shell is not scored by the tool dragging over it. The construction of this tool is more clearly shown in Fig. 6, to which reference should now be made.

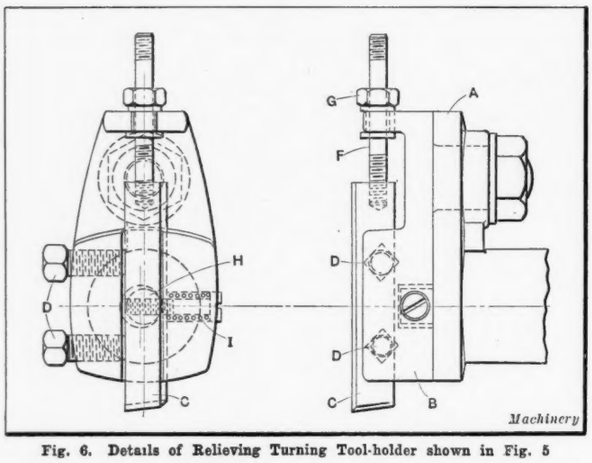


Fig. 6. Details of Relieving Turning Tool-holder shown in Fig. 5

As is clearly shown in this illustration, the turret relieving turning tool comprises a shank on which is fulcrumed a tool-holding member *B*. This is slotted out to carry the turning tool *C* which is clamped in place by two set-screws *D* and is adjusted to turn the correct diameter by means of an adjusting stud and clamping nut *F* and *G*. The method of operating this tool is as follows: The fulcrumed tool-holder *B* is "held up" by means of a fillister-head screw, screwed into a stud *H* and acted upon by a coil spring *I*. A hole to receive the stud is drilled in the tool-holder *B*, allowing about 1/16 inch clearance. When the tool is in action it has a reverse position to that shown in the illustration, that is, the turning tool instead of being parallel with the center line is at a slight angle with it. In action, as soon as the turret advances, the tool comes into contact with the work, and the work, turning around, forces the cutting tool down and consequently depresses the spring, at the same time bringing the "lower part" of the hole into contact with the extended plug on the holder. In this way the tool is held rigidly and in contact with the work. As soon as the turret begins to move back, however, and the cutting pressure is released, the spring comes into action and throws up the tool, bringing it out of contact with the work.

Upon the completion of the operation which is accomplished from the second turret face, the turret is again indexed and the next operation is performed from the rear cross-slide and the third turret face. The third operation consists in cutting the grooves for the rifling band, and on account of the undercutting necessary involves some interesting points. In order to hold the work rigidly while the grooving tools are acting on it, a revolving support *F* is brought in from the turret. The wide tool *G* for cutting the band grooves (this tool removes the greatest amount of stock) is held on the rear cross-slide and is of the under-cutting type; that is to say, it operates under the work or tangentially instead of radially. Held on a bracket on the third turret face are two tools *H* and *I*, the purpose of which is to dovetail the rifling band grooves. These turret tools are held in a holder working in a slide on the bracket fastened to the turret face and are operated by a block held on the rear cross-slide. The action of these three tools, therefore, is simultaneous. The wide grooving tool, however, is slightly ahead of the dovetailing tools in action.

The last operation is accomplished when the turret is indexed to the fourth position. Here, again, a roller support *J* steadies the work while the waving tool is in action on it. The two waves that are formed are for the purpose of preventing the rifling ring from turning, and they deviate about 1/16 inch laterally from being a true annular rib. The tool for cutting these ribs is shown at *K* and is of the forming type held in a dovetailed groove in the holder *L*. This also carries a roll *M* which contacts with the waved surface of the face cam *N*, the curve of which gives the correct, out-and-in motions to the waving tool *K*. The cam face is on a sleeve that is threaded onto the nose of the spindle of the machine, as is shown to the left of the illustration opposite the first turret face.

Method of Holding Shell for Second Operation

The second series of operations on the shell is also performed on the Potter & Johnston automatic chucking and turning machine. The shell is held at the base end by a special collet of the draw-in type, as shown in Fig. 7. Fixed in the nose of the spindle is a positive stop *A* against which the shell is held by means of the draw-in collet *B*. This collet extends into the draw-in rod *C*, to which it is attached. The method of operating this gripping mechanism differs slightly from that shown in Fig. 4. In this case the spring collet *B* is drawn into a tapered sleeve to clamp it on the work. This is effected by means of lever *D* which is fulcrumed in a

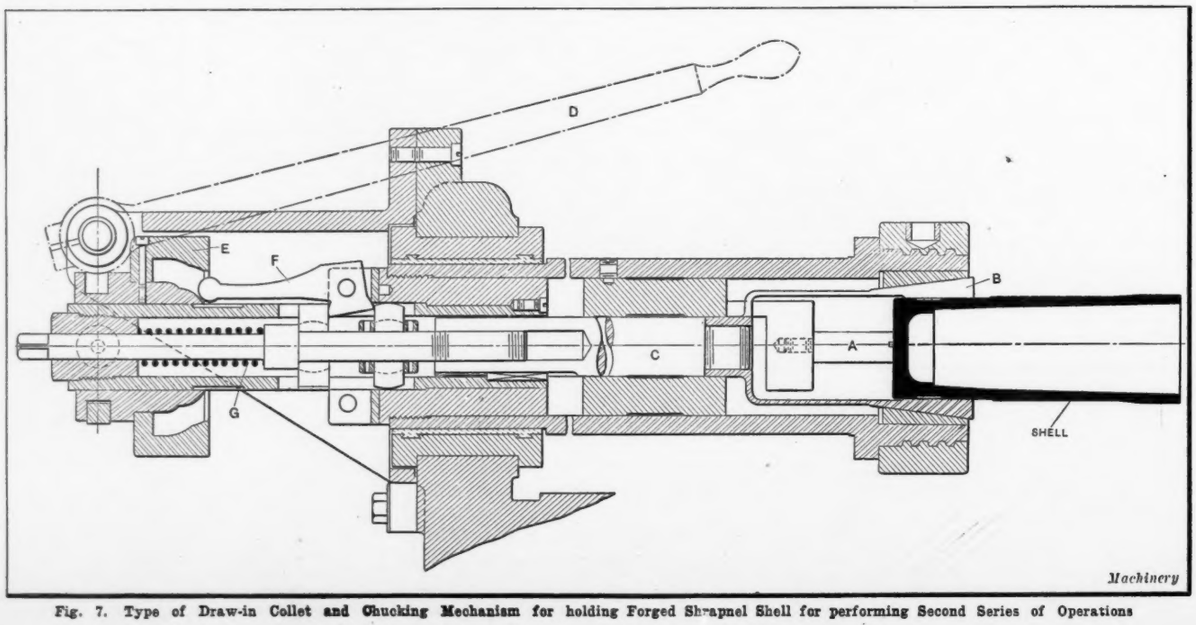


Fig. 7. Type of Draw-in Collet and Chucking Mechanism for holding Forged Shrapnel Shell for performing Second Series of Operations

bracket extending from the rear bearing cap of the machine and operates a sliding cam sleeve *E*. The cam, in turn, operates fingers *F*, only one of which is shown, the latter acting upon the draw-in rod *C* to which the collet is attached. By depressing lever *D*, the chuck is opened by means of the coil springs *G* which act upon the draw-in rod *C* when the pressure of the fingers has been released. Lifting up handle *D* closes the chuck, and depressing it opens the chuck.

Second Series of Machining Operations on Shrapnel Shells

The operations on the shrapnel shell performed in the second setting are shown in Fig. 8. The relieving tool *A*, held on the first face of the turret, covers that section of the shell which in the former operation was held in the gripping jaws. While this cut is being taken, a turret tool *B* rough-bores the powder pocket and diaphragm seat. The relieving tool *A* is constructed and operated similarly to the relieving tool described in connection with Fig. 6. It will be noted here that the threads on the spindle nose are protected by a cast-iron cap to prevent them from being injured.

Upon the completion of the operation just described, the turret is indexed, bringing the second face in line with the spindle. Here the diaphragm seat is finished with a flat cutter *C*, which is held in the boring tool illustrated. The turret is again indexed into the third position, where the powder pocket is finished in a similar manner by means of the flat cutter *D*.

The turret is now indexed to bring the fourth face in line with the spindle where the extreme open end of the shell is turned taper by means of a tool *E* that is carried on the front cross-slide and operated by the turret. By referring to this illustration, it will be noticed that the taper is turned from the spindle toward the outer end of the shell and is, therefore, a reverse turning operation. The tool is caused to move toward the turret by using a rack and pinion to reverse the movement. On this operation, as well as on the previous one, one man takes care of four machines.

Third Machining Operations on Shrapnel Shells

Before any other machining operations are done on the shell, it is taken to a lead bath where it is heated and afterward placed under a press which closes in the nose or open end of the shell. For machining in the third operation, the shell is held practically in the same manner as for the second operation, except that it is gripped farther along the body. The machining performed in this operation is as follows: On the first turret face, rough-bore and finish-bore for a distance of 1 inch from the end of the shell; second turret face, rough-bore the inside of the shell for a distance of 1 inch back from the thread; third turret face, finish-form on the inside for a distance 1 inch back of the thread; and fourth turret face, thread with a collapsible tap. The various machining operations on the 3-inch size of shrapnel shells are performed on a standard Potter & Johnston 6A automatic chucking and turning lathe. It is recommended that these machines be run in batteries or units of seven each, four machines being set up for the first operation, two machines for the second operation, and one machine for the third operation.

Shrapnel shells are also made from bar stock, but this type of shell is not held in as high favor as the forged shell, as mentioned. The operations on the bar shell do not differ materially from those on the forged shell, except that the chuck jaws are used for holding the stock in the first operation, and the work is performed as follows: First, rough-turn the outside diameter as far as the chuck jaws, face end, round the corners; second, finish-turn outside diameter, also finish 3½ inches up; third, cut band groove and dovetail; fourth, cut irregular annular ribs in the band groove. In this case the cam for operating the wave cutting tool is placed on the chuck face.

The second operation on the shell made from bar stock is, of course, entirely different from the forged shell as the interior of the shell must be worked out to a depth of approximately 8 inches. This is done with a step drill in the first position. In the second position the reamer is run in for reaming the tapered hole; third, the short distance on the open end is turned, and the taper on the periphery is turned with the cross-slide tool, the surplus stock left by the first drill being removed from the powder pocket. At the fourth turret position, the powder pocket is bored and the diaphragm seat is completed. The shell is then "nosed in," and the third operation performed, which is identical with that described in connection with the forged shell.

This method of manufacture, together with the operations performed on Potter & Johnston automatic chucking and turning machines in the production of brass cases for shrapnel, will be described in a subsequent article.

D. T. H.

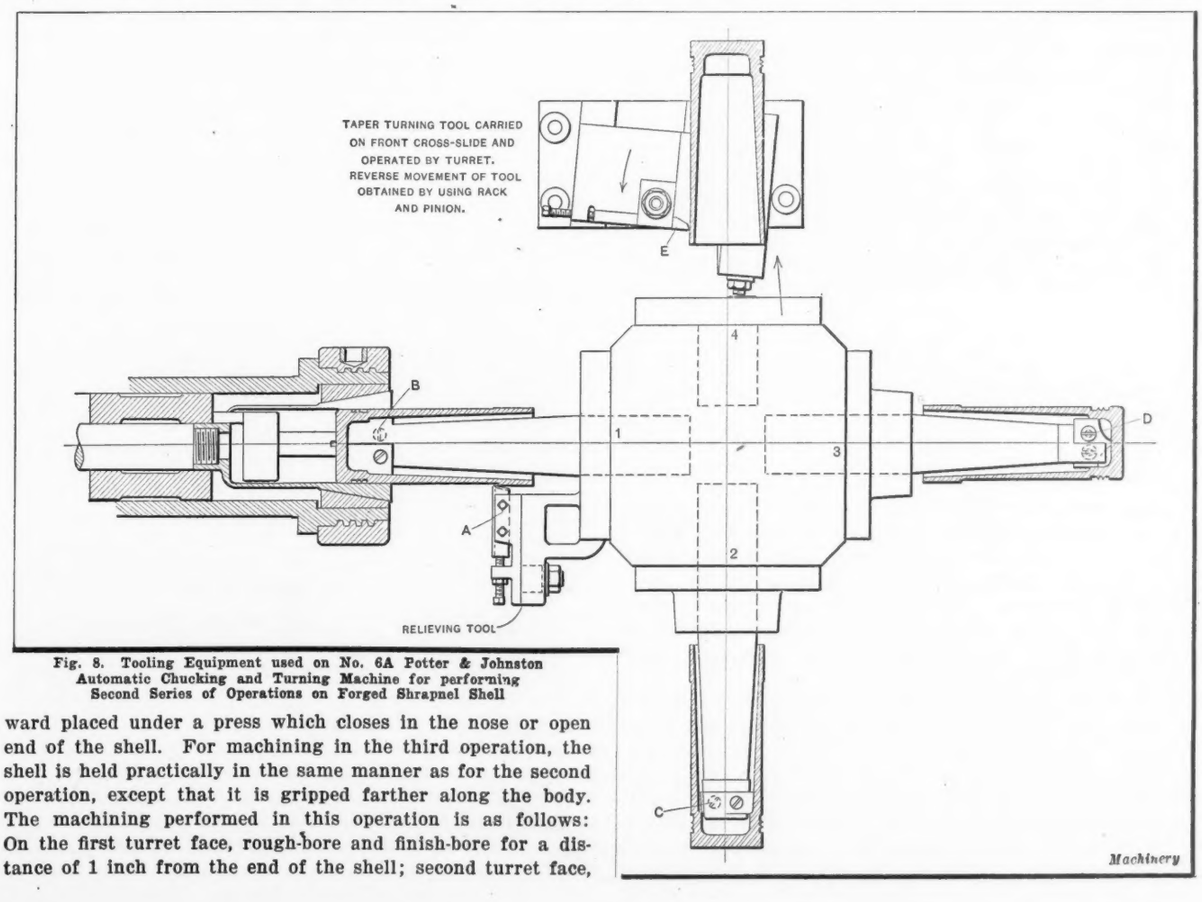


Fig. 8. Tooling Equipment used on No. 6A Potter & Johnston Automatic Chucking and Turning Machine for performing Second Series of Operations on Forged Shrapnel Shell

ECHOES FROM THE REPAIR SHOP

BY A. P. PRESS

For a long time I have been foreman of an automobile repair shop, and some of the cases that come before the door (they do not all come in) are worth describing. The foreman of a large automobile repair shop has a hard job, and if he has, say, a hundred jobs on the floor which are owned by one hundred different men, he virtually has a hundred "bosses" all of whom he is trying to satisfy—and some of them never can be satisfied. Every man that owns a car, especially if he drives it, knows his car thoroughly, and he expects the foreman to know it equally well. A case came up recently that will illustrate this point.

A car came in for a complete overhauling. On the front of the dash-board were four little holes, and also a spot where a square plate had been taken off. We supposed it had been removed simply for safekeeping. Well, the car went through the mill—it was overhauled, painted and the dash-board refinished, but the four little holes were not plugged up. When the man came to get his car there was a "circus." It seems that it had formerly belonged to some club and the present owner had removed the plate and wanted the spot and holes refinished, but he forgot to speak of it. There was a stormy time for a half hour, and the outcome was that we had to pull the dash-board off and thoroughly refinish it all over so as to cover up the spot.

Some of the cases are more ludicrous, however. A gentleman—and he was a gentleman, too—came driving in one day and said he wished certain repairs made on the rear end of the car. He said if he jacked up the car and turned one wheel one way, the other would revolve in the opposite direction. (This, of course, is the natural action of the differential gear.) It seems this party had gone down to another garage where he was told that the transmission was entirely gone and that a new one would have to be installed; but before leaving the car for repairs, he drove down our way to see what we would say about it. It took a half hour of earnest explanation to convince him that his car was absolutely all right, and also to explain to him the purpose of the differential. All this had to be done without a smile or he would naturally have been offended and gone away indignant; but once he was convinced, we made a customer for life, and a box of cigars which he sent around the next day showed his appreciation. Of course no charge can be made for a "job" of this kind.

And then the ladies—for we have a good many of them who own and drive their own cars—give us some bad moments. One came in not long ago and she wished the oiler removed, thoroughly cleaned out and replaced; a leak soldered in the radiator; and the carbureter adjusted and "tuned" up—at least a half day's work. She said she could not leave the car over ten or fifteen minutes, as she had to catch a train some miles away. Did she get it? Yes—two days afterward, and we had to send her to meet the train in one of our own cars. Still, with all the troubles, there are some bright spots that help to relieve the strenuousness of the job.

There was the lady who came in and purchased a high-grade car; and in addition she was to be taught how to operate it herself, and for that reason it must not crank too hard. She wore a hobble skirt of some exquisite material—satin I thought. She insisted upon a Harrel bumper on the front of the car. The combination of the Harrel bumper and the hobble skirt was too great for the best interests of the garage. However, I must say she was equal to the situation, and the way she learned to step over that bumper and crank that car, and to handle it afterward was a feat to be remembered.

Naturally we had a great deal of outside testing to do and some of it is speed testing. One instance, which we call the "seventy-mile case," is still a by-word in the room. The customer bought the car with the understanding that he would not accept it unless it made seventy miles an hour. He came from Missouri and he "wanted to be shown." When the car was ready (we had taken it out once before and knew it would make the seventy) our customer came down to see the test, and took a seat in the rear of the tonneau. We took the car out on the turnpike which was a long stretch of woods about five miles from the shop, and where we were reasonably sure that the cops would not see us—or would look the other way if they did. The car was warmed up for a few moments and then started down the pike. When the indicator got near the seventy mark, the mechanic turned around to the customer and said: "There she is at 70. Do you want to see it?" The customer was lying back in the seat, his face as white as chalk. "Y—yes! yes!" said he. "Yes, I am satisfied. Slow her down!" He got his car and we got our money, but we do not think that indicator ever touched the seventy-mile mark again.

Here is another incident that will bear telling. One day two of the boys were out on the road testing a car, and when they got well out into the country they found that the radiator was leaking and that they would have to get a little water somewhere. So they stopped at the next farmhouse and one of the mechanics took a collapsible rubber pail and went around the back of the house. He could not find a pump so he knocked at the door and went inside and filled it at the sink. As he stood there with the pail in his hand he got to talking with the hired girl, and he had occasion to set the pail down on the floor. Why he did it is a question, but anyhow he wanted to use both arms. Now when you set a rubber collapsible pail full of water on the floor there is something doing right off, and this case was no exception. He grabbed the pail with what was left of the water and hurried out. The radiator had to wait until they got to the next farmhouse before it was filled.

To come back to the practical side of automobile repair work, a systematic method of keeping track of the car—what is to be done and what has been done—is a great help in giving satisfaction to customers. It will not help at all the job that requires two days and is wanted in fifteen minutes, but it will enable a foreman to tell just where he is at on each and every job; and about when he can deliver the same and do it with the least expenditure of gray matter on his part, or clerical work in the office.

* * *

SAFETY MEDAL AWARDS

The American Museum of Safety awarded on February 10, at the United Engineering Societies building, six safety medals as follows: The Scientific American medal, awarded for the most efficient safety device invented within a certain number of years and exhibited at the museum, was given to the Shurloc Elevator Safety Co., Inc., New York City. The Travelers Insurance Co.'s medal, awarded to the American employer who has excelled in protecting the lives and limbs of workmen, was given to the Commonwealth Edison Co. of Chicago. The Louis Livingston Seaman medal, awarded for progress and achievement in the promotion of hygiene and the mitigation of occupational disease, was given to Surgeon-General William C. Gorgas. The E. H. Harriman memorial medal, awarded to the American steam railroad which during the year has been the most successful in protecting the lives and health of its employes and of the public, was given to the New York Central Railroad Co. The Anthony N. Brady memorial medal, awarded to that American electric railway company which for the year of the award shall have done most to conserve the safety and health of the public and of its employes, was given to the Boston Elevated Railway Co. The jury of award also gave honorable mention to the Public Service Railway Co., New Jersey, and the Northern Ohio Traction and Light Co.

* * *

That the German metal industry suffers considerably from the lack of raw materials, all assurances to the contrary notwithstanding, is indicated by the high prices at present quoted in the German market for certain metals; thus, copper is now quoted in Germany at twice the price of the current quotation in other countries, and aluminum is quoted at three times the price prevailing when the war began. Antimony costs about four times as much as when the war broke out.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

ASSEMBLING FIXTURE FOR FRANKLIN FRONT AND REAR AXLES

A labor saving assembling fixture used for assembling the front and rear axles of Franklin motor cars has been de-

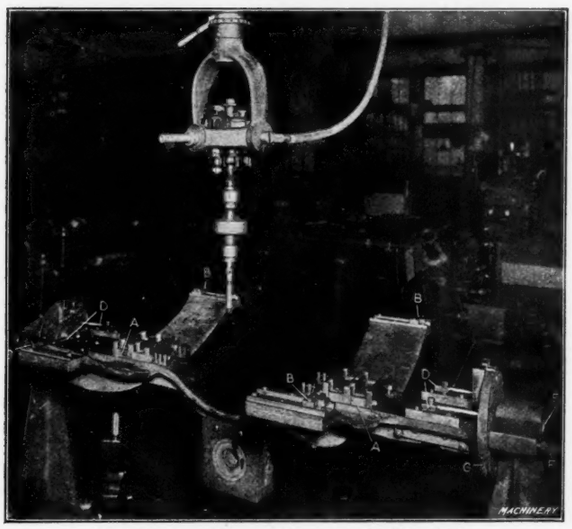


Fig. 1. Assembling Fixture for Franklin Axles

signed, built and is now in operation at the factory of the H. H. Franklin Mfg. Co., Syracuse, N. Y., through whose courtesy the accompanying illustrations are shown. Fig. 1 shows the fixture without work on it, while Figs. 2 and 3 illustrate two phases of the assembling operation.

The work done on this fixture is assembling the sets of springs to the axle by means of U-bolts, making several adjustments inside the differential case and bolting the differential case cover to the case. The assembled springs, and also the axle completely assembled except for the springs, come to the fixture ready to be put together. A pneumatic drill outfit is used for setting the bolts, and it is suspended overhead for convenience, being mounted on a universal joint, which makes it easy to manipulate. The operation is started with the fixture in the position shown in Figs. 1 and 2. The four U-bolts are put in position, two in each end of the fixture, and located in grooves in blocks *A*. It will be noticed that there are two slots in each of these blocks, thus permitting of assembling either the front or the rear axles,

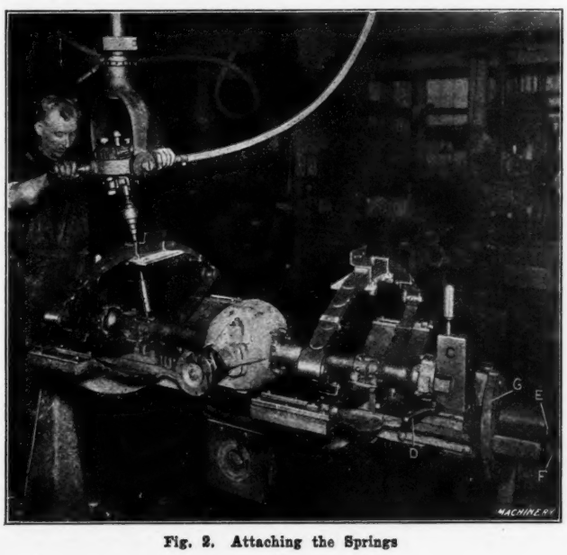


Fig. 2. Attaching the Springs

which differ in width. After the U-bolts are in place, the springs are set in these blocks and the horizontal alignment of the pair of springs is made by adjusting the springs to gages carried in the slots of the blocks *B* which are located on the projecting arms of the fixture. In conjunction with this (in the case of the rear axle) the axle is correctly located by means of the end blocks *C*, which are not shown in Fig. 1 but may be plainly seen in Fig. 2. Passing down through these end blocks are locating pins that engage the ends of the axle and hold it while the assembling is being done. These end blocks may be slid in or out of the fixture between ways, and when located are clamped by lever bolts *D*. The operation of setting the nuts on the bolts is quickly performed by using the pneumatic drill, as shown in Fig. 2. This is a "Thor" pneumatic drill made by the Independent Pneumatic Tool Co. and in connection with it a "Magic" chuck is used with a nut setter that insures each of the nuts being set up to the same tension.

The entire fixture for holding the springs and axle is mounted on trunnions so that it may be swiveled about point *E*. While locating the fixture in either plane, a pin *F* is used that engages holes in the disk *G*. The fixture is used in the vertical plane while several adjustments are being made on the differential mechanism within the case, after which the cover is put in place and the cap-screws that secure it are

Fig. 3. The Last Operation—Bolting Down the Differential Case Cover

set by means of the nut setter on the overhead pneumatic drill. By the use of this fixture, the assembling of the springs and axle is easily performed, and the time for the operation has been greatly reduced.

C. L. L.

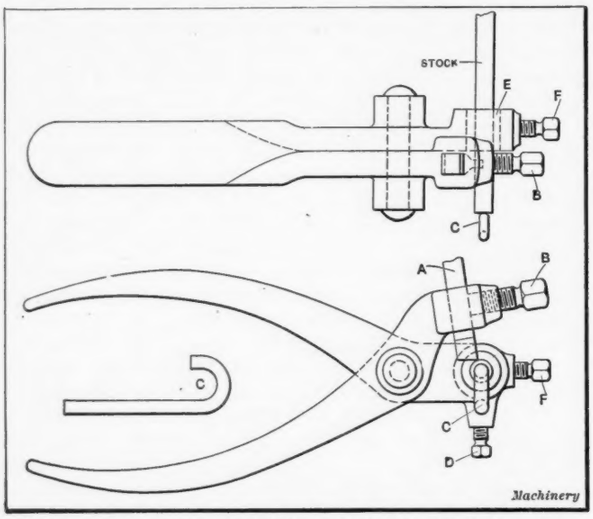
HOW SHOULD THE GRAIN RUN?

Referring to the "How and Why" article in the January number of MACHINERY, page 414, entitled, "How Should the Grain Run?" the writer would say that many toolmakers believe that steel, as manufactured today, is so homogeneous that there is no grain in the sense in which this word has been used in the past when referring to wrought iron. There is no tendency to open, under strain, along lines parallel with the sides of the bar. In the minds of many, the word grain represents a condition similar to the grain of wood. Even if we could imagine that a bar of tool steel were as fibrous as a bar of iron, it is difficult to see how a cutter made as shown at *C* in Fig. 2 in the article referred to would be as lasting as one made with the grain in the other direction; but with steel homogeneous in structure this consideration is probably of no account anyway.

Turtle Creek, Pa. WILLIAM S. ROWELL

CUT-OFF TOOL FOR SMALL PINS

It is sometimes necessary to cut off several dozen small dowel pins, the usual method of doing this work consisting of cutting off the pins with a hacksaw and then filing them up in a speed lathe. The accompanying illustration shows a handy tool for cutting off such pins, which is provided with a cutter ground in such a way that the ends of the pins are rounded up without the necessity of filing them. The cutter



Tool for cutting off Pins and finishing their Ends in a Single Operation

A is made of ¼-inch high-speed steel, and is held in place by a suitable set-screw *B*. It will be seen that in general appearance the tool resembles a pair of pliers, the cutter being mounted in one jaw and an adjustable stop *C* being carried in the other jaw. The stop is held in place by a set-screw *D* and may be adjusted to provide for cutting off pins of different lengths. In order to adapt the tool for handling different sizes of stock, hardened steel bushings with different sized holes are used, the bushing *E* being mounted in the same jaw with the stop and held in place by a set-screw *F*.

Swissvale, Pa. WILLIAM MURSCH

ONCE MORE—SHORT FOREIGN POSTAGE

The writer wishes to draw the attention of American manufacturers to a matter which is of the pin-prick order. In nearly every case when manufacturers send us catalogues and letters, insufficient postage is prepaid. We have at this end the option of refusing delivery or paying 3d (6 cents) per letter. The mail this morning cost me about 40 cents. Now there is no necessity for this, and I am sure your advertisers, with some of whom I have had satisfactory business, would be glad to prevent the recurrence of this slight annoyance.

Auckland, New Zealand F. J. CULLEN
Cullen & Coy, Mechanical Engineers

SENSIBLE CATALOGUES

I often wonder why manufacturers do not get out more business-like catalogues. There seems to be a tendency nowadays to spend a great deal of money on art for catalogues, which is certainly all right so long as the artistic end is not overdone; but that does not necessarily make the book a useful tool. A catalogue should be economic, first, and second, it should be useful; if it is not useful how can it be economic?

Ninety-nine buyers in a hundred do not care for a fancy catalogue. All they want is something sensible. A durable book that will withstand wear is most desirable. A convenient filing size—6 by 9 inches—is also wanted. Show plenty of pictures but don't show useless pictures to tire the reader before he gets to the vital point. And don't say too much.

Before getting out your next catalogue take a look at the catalogues of some of our big mail order houses. They are almost beyond criticism. Everything is illustrated; the descriptions are concise, yet nothing of value is omitted; and the prices are given. There is no discount. That is one of the principal reasons why those houses are so successful. Their catalogues are equally valuable in Alaska, Australia, Africa and America.

Just for "effect" it may be all right to get out a work of pure art once in a while, but don't make a practice of it.

N. G. NEAR

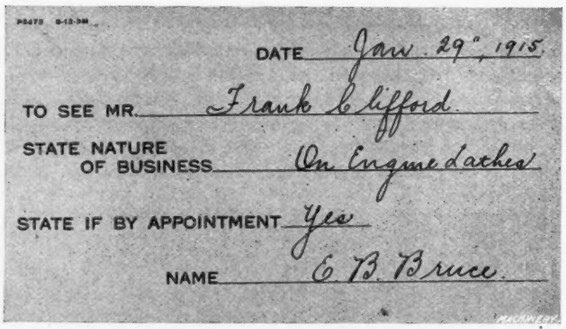
HANDLING OFFICE VISITORS

The interesting method for the courteous and efficient treatment of office visitors by using a private telephone system, described in the December number of MACHINERY, brings to the writer's mind an equally effective arrangement established throughout the works of a large electric light and power company on the Pacific coast and which, additionally, does not require any time of officials unless fully warranted. Callers for any and all departments are received by a diplomatic young man and handed a small writing tablet about 3 by 5 inches in size, carrying wording as shown in the specimen here reproduced. No visitor worthy of attention will object to filling this out, and the sheet pulled from the pad is taken immediately to the official or department head whom the visitor desires to see.

A glance at this blank informs the official of the name of the caller and the nature of his business, and should he justify attention it can be given. On the other hand, in the case of an obviously needless interview, a polite refusal explaining the impossibility or uselessness of seeing him at that particular time and, if desired, requesting that he call again, can be reported at once to the messenger and transmitted to the visitor. By this arrangement no time is unnecessarily consumed and no particular harm is done should the visitor not be seen, while the importance of the official and the demands upon his time are impressed upon the caller. Further, the proper filing of these slips from week to week, with notations as to whether an interview resulted or not, affords an accurate reference to callers in the past, as it frequently becomes necessary to trace matters of this kind for a complete record of different conditions.

A. R.

[In comparing the present system with that described in the December number of MACHINERY, the writer has over-


DATE Jan. 29th, 1915.
TO SEE MR. Frank Clifford.
STATE NATURE OF BUSINESS On Engine Lathes
STATE IF BY APPOINTMENT Yes
NAME E. B. Bruce.

Form used by Office Visitors in making Application for an Interview

looked the fact that the use of the private telephone system enables the caller to come into personal contact with the man he wishes to see, so that in case he is not granted an interview, he does not go away with the feeling of having failed entirely in bringing his project to the attention of the proper individual.—EDITOR.]

CLAMPING DEVICES FOR JIGS AND FIXTURES

In Fig. 1 is shown a clamping device that has been found useful on large work. It consists of four arms *A* with the ends bent to a right angle and knurled so as to hold the work firmly in place. These arms are pivoted on the stud *B* and their action is guided by the blocks *C*. The spring handle *E* is pinned to the shank of the stud, and the upper edge of the

handle is beveled to fit the rack *D*, which is fastened to the side of the base. By turning the handle in the direction indicated by the arrow the work is securely clamped; and if necessary, ordinary straps may be added for holding the work.

When making tools for thin castings of odd shapes, it is often desirable to use an adjustable clamping device that can be easily moved out of the way when reloading the fixture.

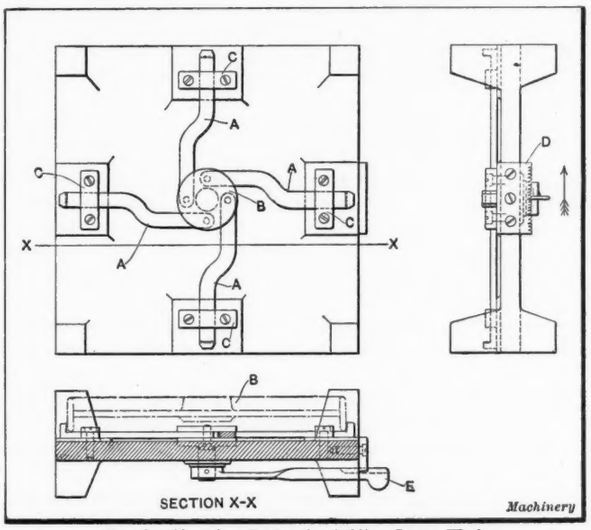


Fig. 1. Clamping Device for holding Large Work

Such a floating clamp is shown in Fig. 2, where the piece of work to be drilled was properly located and clamped, with the exception of one arm *E*, for which no ordinary clamp could be used. By pushing the support *A* down against the work and clamping the strap *B*, the work is held tight without springing it; and by tightening the nut *C* the clamp is held in place by the bunter and the work is securely supported. When reloading the fixture, the clamp is brought out of the way by means of the handle *D*.

In Fig. 3 is shown a small clamping device used when drilling the rivet holes through the beading *A* and the plate *B*. The steel bracket *C* is fastened by screws to the side of the fixture. The front face of the clamp bracket is used as a stop for the plate and the beading, and the clamp *D* with a small hole drilled in one end is fitted loosely in the milled slot in the bracket. The set-screw is located a little higher than the hole in the clamp and by a few turns of the screw, the clamp is brought down against the work and forces the beading up against the stop ready to be drilled.

Spring bunters are often used in designing fixtures where adjustable supports are necessary, and the form of bunter shown in Fig. 4 has proved very efficient. The bunter *A* and the binder *B* fit freely in the holes in the casting. The bunter is slightly tapered and a tapered flat is milled on one side of the binder. When the fixture is loaded the spring *D* forces the bunter up against the work, and by means of the cam *C* the binder is pulled outward and holds the bunter firmly in place. The double taper on both bunter and binder makes it impossible to press the bunter downward away from the work.

Hartford, Conn. S. HELWEG

DEVELOPING A TYPEWRITER

As there has several times been expressed an interest in the time and cost of bringing out small mechanisms of various sorts, it may be worth while to place on record the following experience. It was my fortune, some years ago, to be engaged to go to a western city to take part in the development of a typewriter. I landed in that city on June 22. The manager, who was also the inventor of the improvement we were to put into practicable shape, had engaged a room on the upper floor of an office building, and had ordered an engine lathe, a milling machine, a shaper, a bench lathe, a small bench emery grinder, a portable forge, an anvil, and a three-horsepower electric motor.

Our first aim was to get the shop fitted up ready for work. One machinist was engaged, the machinery put in place, shafting, hangers, pulleys and belting bought, and all set up in running order. About fifteen feet of bench was put up with two vises, and the necessary equipment of small tools and supplies procured, including drills, taps, reamers, counterbores, files, steel, brass, waste, oil, etc. While this work was progressing, the manager went over with the writer, in detail, the previous steps in his invention, its present condition, and his conception of further improvement. Several model machines had been made, mostly in a crude and primitive manner, but the latest one had been made in a well equipped eastern factory. Each model showed distinct progress, yet further improvement was necessary before reaching a practicable stage.

The situation did not permit making complete drawings of the proposed machine before beginning work; it was necessary to take one feature of the machine at a time, such as frame, carriage, levers, type-bars, etc., decide upon it, and get the work started. A jobbing patternmaker was found in the city, and as soon as each part of the frame, that is, side frames, back, front, top, etc., was decided upon, it was drawn,

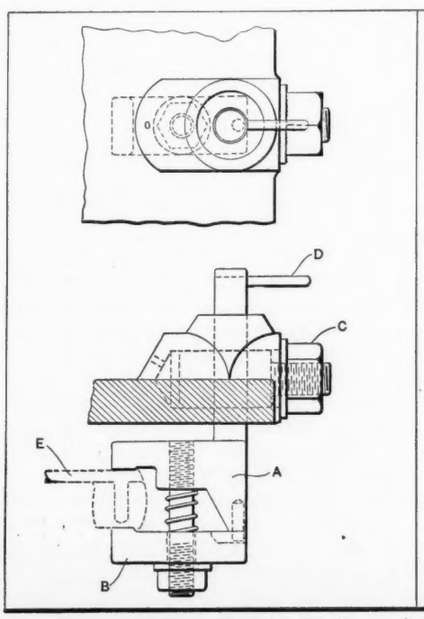


Fig. 2. Auxiliary Clamp for Use in holding Odd Shaped Castings

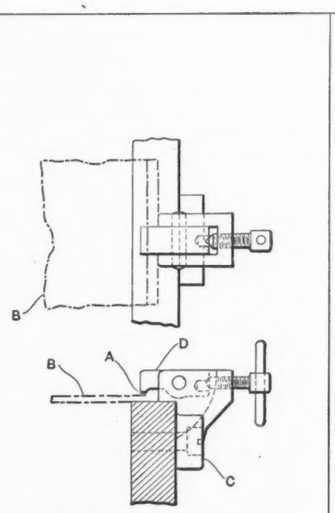


Fig. 3. Special Clamping Device for drilling Rivet Holes

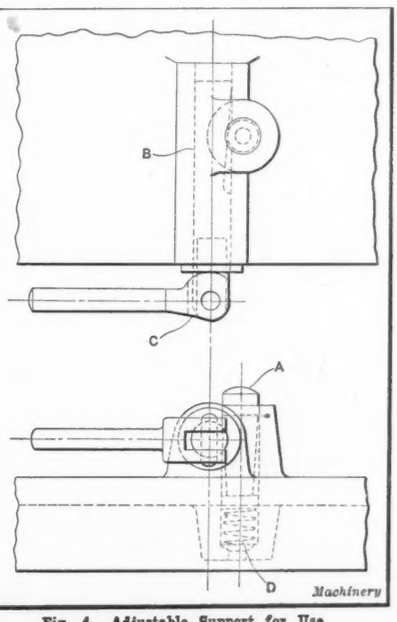


Fig. 4. Adjustable Support for Use in holding Work in a Jig

the pattern made, and castings procured. As soon as the plan was sufficiently developed, another machinist was engaged.

Fortunately, the inventor was not of the typical kind, usually portrayed in literature; on the contrary, we worked together smoothly, he giving his ideas of the improvements to be attained, and not interfering with the technical processes. There were some set-backs, of course; some plans were tried and found not practicable, and had to be changed.

The only parts bought were the roller—commonly, but erroneously called "platen"—and the types; all other parts were cut out of the bars, rods and sheets. Neither of the two machinists employed had ever worked on typewriters or in any shop east of the Mississippi River, yet on October 22, four months from the beginning of operations, the typewriter was finished, at a total cost, for wages and current expenses, of about fourteen hundred dollars.

Brooklyn, N. Y. JAMES DANGERFIELD

JIG AND FIXTURE DESIGN

In the May number of MACHINERY, Charles Staples raises several points in regard to my article on jig and fixture design that was published in the December, 1913, number of MACHINERY. It seems that the points raised by Mr. Staples can properly be made the subject for further discussion, owing to the differences of opinion which exist in regard to this matter. This is particularly true of the question of where square-head screws should be used, where knurled-head screws should be employed, and where a pin should be put through the screw to make it easier to turn.

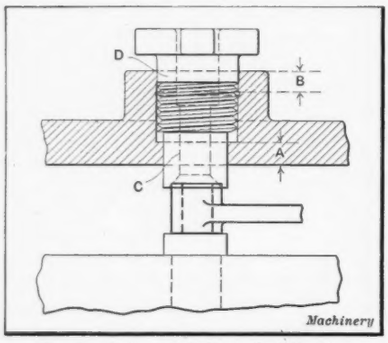


Fig. 1. Design of Bell-mouthed Bushing

Taking up the subject of the bell-mouthed bushing referred to, for which Mr. Staples recommended a substitute, the writer agrees that a bell-mouthed screw bushing of the type shown in Fig. 1 of this article has to be made fairly long for the drill when the bushing is used for guiding drills ¼ inch in size or smaller. This increases the chances of breaking the drill, but whether the breakage which results from this cause is likely to assume serious proportions, is a question which is open to some argument. For guiding drills larger than ¼ inch in size, I do not believe that any trouble with broken drills would result.

Another objection to this clamping device, raised by Mr. Staples, is that chips work into the threads of the bushing and prevent it from turning easily; and the claim is made that this shortens the life of the threads. In this connection, I would call attention to the fact that the bushing is constructed in such a way that chips are excluded from the thread. By not tapping the hole all of the way through, as indicated at *A;* and by counterboring the hole at the top marked *B;* and then grinding the pilot *C* and shoulder *D* on the bushing to a snug running fit, the bushing is held true and chips are excluded from the thread.

It might be well to note that while the writer's experience

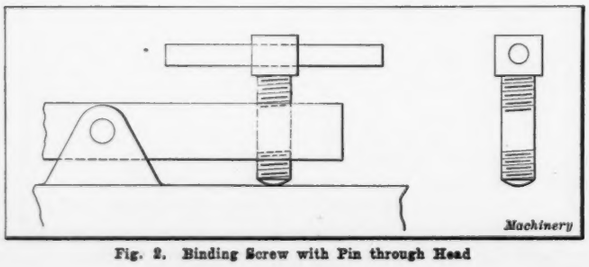


Fig. 2. Binding Screw with Pin through Head

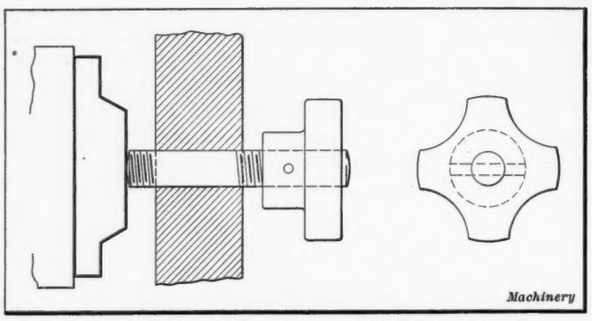


Fig. 3. Hand Knob for Binding Screw that gives Good Results

has shown that the average tool designer has no love for screw bushings and will avoid their use whenever possible, such bushings are frequently selected after careful consideration because of their neat appearance and effective operation. The danger of breaking drills is really not a matter of primary importance because the general run of work with a boss on it, is of such a size that the drills are too large to be easily broken. It also appears that Mr. Staples has been rather hasty in advocating the method of tightening a screw by means of a pin through its head, as shown in Fig. 2, in preference to a hand knob on the screw, as shown in Fig. 3. The method illustrated in Fig. 2 is often used, and it has been the writer's experience that on large fixtures where the pin is ½ inch in diameter and requires the use of both hands, it works very effectively. On smaller sizes of fixtures where the pin is about ¼ inch in diameter by 4 inches long, and must be used with one hand, the pressure is concentrated across the palm of the hand, and if the fixture is used frequently it is likely to develop a sore spot.

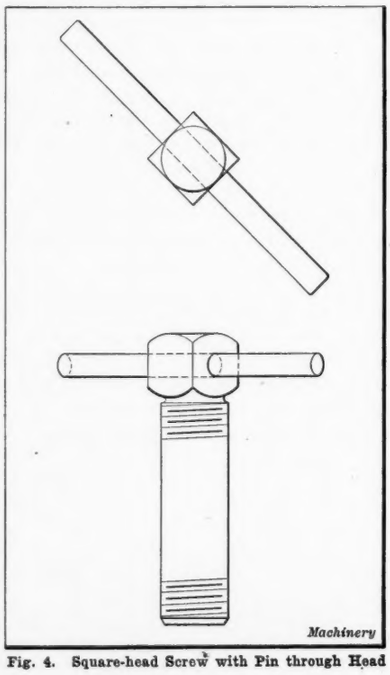
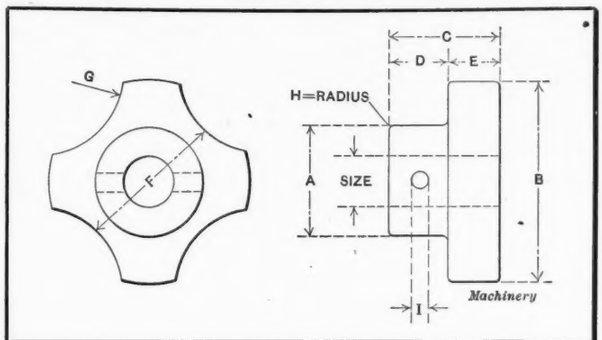


Fig. 4. Square-head Screw with Pin through Head

In the case of the hand knob shown in Fig. 3, however, it is evident that the pressure is distributed over the palm of the hand, and therefore the likelihood of producing a sore is much less. A table of sizes of knobs for different classes of fixtures is presented in this connection. If the writer used a pin and screw as recommended in Mr. Staple's article, the screw would have been made as shown in Fig. 4, with a square head through which the pin passes. The object of this design is to use the pin for turning the screw quickly until it is down in place, and then to make a final clamping by putting a suitable wrench on the square head and tightening the screw down in the usual manner.

The questions naturally arise, how much pressure can a man exert with his fingers in operating a knurled-head screw, how much pressure can he develop with a screw and hand knob, and how much pressure can he exert in operating a screw with a pin through it? It is quite safe to say that for continuous operation on jigs or fixtures all that can be depended upon with a knurled-head screw is to bring the screw up to steady the work, but with a screw and pin through it, it is not uncommon to bend the pin. With a hand knob the amount of pressure is doubtful and depends largely upon a man's endurance and the position of the screw, which governs

TABLE OF DIMENSIONS* FOR CAST-IRON KNOBS



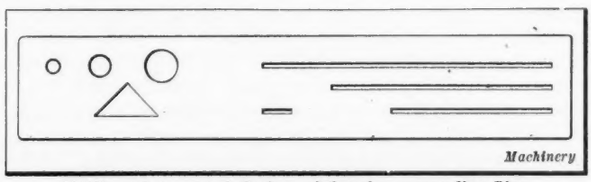
Size	5/16	3/8	1/2	5/8	3/4
A	1 1/16	7/8	1 1/16	1 1/4	1 1/2
B	1 1/2	1 5/8	2 1/8	2 1/2	3
C	1 1/16	1/2	1	1 1/16	1 1/2
D	5/8	1/2	5/8	5/8	5/8
E	5/16	3/8	7/16	1/2	1/2
F	1/2	1	1 1/16	1 1/2	1 1/2
G	1/2	15/16	5/8	1/2	1
H	1/16	3/32	1/16	1/16	1/16
I	3/32	3/32	1/8	3/16	3/16

* All dimensions given in inches.

the grip that he can get on the knob. While I cannot see where the pin and screw has any advantage over the hand knob, when suitably proportioned, there seems to be a great difference of opinion as to where to draw the line between the use of a hand knob and of a square-head screw. This matter is often decided by the personal preference of the designer, my experience being that in a jobbing shop where hand knobs are used quite extensively, an occasional request is made for square-head clamping screws. SERVER

ERASING INK LINES

Draftsmen often have trouble in erasing ink lines on bond paper or tracing cloth and if this is not well done an unsightly defect in the drawing will result. Errors will often creep into the work regardless of the amount of care which may be exercised by the draftsman, and as machines and tools are repeatedly rebuilt, improvements are constantly being made which require erasures on the standard drawings. If these changes are not of great magnitude it is much cheaper to make them on the original tracings than to make complete



Shield used to protect Surface of Drawing surrounding Line to be erased

new drawings. On some drawing paper a very sharp knife can be used, but even where the greatest care is taken the surface will be left ragged and no eraser will smooth it down sufficiently to allow a clean-cut ink line to be drawn. The same trouble is experienced in using ink erasers, and those who have had trouble with either method will be glad to hear of a way in which satisfactory results can be obtained.

I have found that the green "III Emerald" pencil erasers made by Eberhardt Faber will remove the ink and not injure the paper at all, so far as the surface is concerned; and these erasers will make the paper very little thinner so that after the new lines have been drawn the places where the changes were made cannot be distinguished from the original work, except by looking through the paper and seeing that it is slightly more transparent. More time is required to make an erasure with one of these pencil erasers than if an ink eraser or a knife was employed, but the results are so superior that any draftsman who takes pride in his work will not wish to return to the old method after he has tried the one which I recommend. Most employers and chief draftsmen will be only too glad to have this additional time spent when they see the superior quality of work which is produced.

To avoid erasing too large a space, the well-known device of using a thin piece of German silver or brass 0.002 to 0.005 inch in thickness, with holes of various sizes and narrow slits of different lengths and widths, can be employed to good advantage, so that only those lines which are incorrect will be erased. I have recommended the particular brand of pencil eraser which I use, but there are undoubtedly many other rubber erasers which will give just as satisfactory results.

SIMEON D. WILLIAMS

METHOD OF MAKING AND USING PIERCING DIES

Without wishing to go on record as approving or disapproving of the article entitled, "Improved Doweling Method for Dies," which appeared in the July number of MACHINERY, the writer feels that a few useful features that would be of general interest could be added to a piercing die of this kind. To begin with, the "set edge" or the "jacket," as the writer of the article calls it, which locates and at the same time holds the blank in the desired position preparatory to piercing, should have the top edge rounded as shown at *A*, Fig. 1;

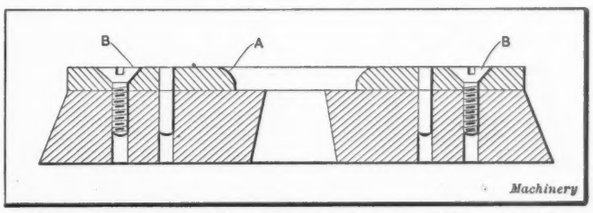


Fig. 1. Method of rounding Mouth of Hole in Set Edge to facilitate placing Blanks

for in this way the operator can more readily slip the blanks into place. It also pays to use bevel headed screws to fasten the set edge to the die, as shown at *B*, in order to prevent the knuckles and fingers of the operator from becoming sore by continually coming into contact with the exposed heads of the screws.

Another point that may be worth while going into is that after the set edge has been filed out to fit the blanks to be pierced (which we will assume are somewhat similar in

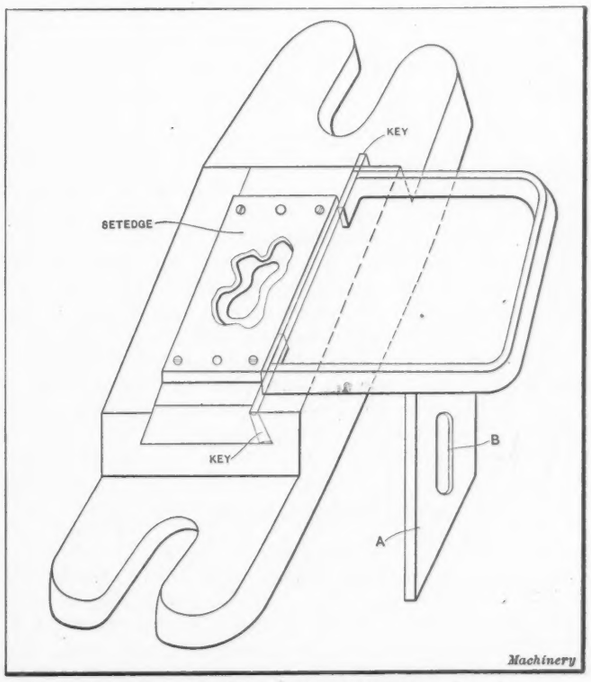
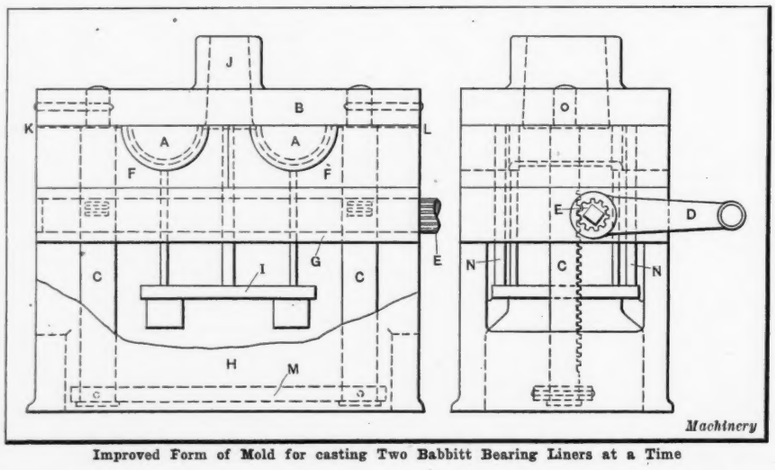


Fig. 2. Type of Container used to hold Work ready to be fed to Piercing Die

shape to the one shown on the top of the die in the article referred to), a scrap punching from the piercing die is laid with the burr-side down on the top of the blank. After the punching has been laid on the blank in the desired position, the outline of the punching is scribed on the face of the blank, and the blank is then slipped into the set edge which is adjusted on top of the piercing die so that the scribed outline of the punching coincides with the irregular shaped hole in the piercing die.

The set edge is then clamped tight to the die, and the position of the tapped holes in the die are readily transferred to the set edge, as the holes are drilled all the way through. Before countersinking the holes in the set edge, it often pays to fasten it to the die with four fillister-head screws and then pierce a few blanks to see if it is in the right position, so that in cases where extreme accuracy is required it can be shifted if desired. After the set edge has been found to be in the right position, the holes for the set pins are drilled and the pins are driven into place. The temporary screws are then removed and the screw holes countersunk.

When piercing blanks or shells that are fed to a die of this kind by hand, the adjustable container for holding them is most useful, for the reason that the container can be so adjusted as to be flush with the top of the set edge, which makes it an easy matter to slide the blanks or shells into the set edge. In most cases this is done by pushing the work in with a small stick, which not only helps to increase the output but also helps to make the job a great deal safer. This container, as shown in Fig. 2, is held in place by the angle piece *A* which is fastened to the bed of the press by cap-screws through the elongated slot *B;* or if the press is a bench power press, the container is fastened to the bench by lag-screws. Two screws in connection with two elongated slots, together with the slot *B*, allows for any desired adjustment. In cases where the work is fed to the die without the aid of a container or other similar device, the usual procedure of the operator is to pick up a handful of the blanks with the left hand and lay them in the set edge with the right, which is a slow and rather dangerous method.



Improved Form of Mold for casting Two Babbitt Bearing Liners at a Time

By using the container, the blanks are readily turned right side up and arranged in line one after the other with one hand, while the other hand slides them into the set edge by the aid of a stick, as previously explained. Another feature of a container of this kind is that it can be used with any number of different kinds of jobs, and does away with the necessity of making a special fixture in order to enable the operator to feed the blanks to the dies readily; also, it can be made suitable for a larger class of work by using two angle pieces similar to the one shown at *A* in Fig. 2, thereby making the container stronger and more serviceable.

Waterbury, Conn. CHARLES DOESCHER

BABBITT BEARING MOLD

Under the title "Babbitt Bearings" in the December number of MACHINERY a pouring mold (Fig. 2) was shown which, in the opinion of the writer, can be considerably improved and thereby produce a higher grade of castings more rapidly. It will be noted that in the pouring position of the mold referred to in this article, the bearing is horizontal and gated at the flange, and that the metal in entering the mold has a tendency to splash and divide into two or more streams. The result is that air is likely to be trapped and so produce a large percentage of porous castings. Denser castings can also be produced by increasing the height of the pouring nozzle, so that the weight of the excess metal will exert a pressure on the bearing as it solidifies and shrinks. In his experience, the writer has found that the hinged construction mold, as illustrated in the article referred to, is exceedingly unreliable. The pressure being applied at the handles, the edge along that side will always be kept tight shut; but the joint on the hinge side will have a tendency to open, the opening increasing with the wear in the hinge, and in a comparatively short time a leakage of babbitt will take place at that point.

The accompanying illustration represents a multiple mold which overcomes the defects mentioned and is especially adapted for quantity production. The cores *A* form the inside as well as the over-all length of the bearings, and projections can be milled on them to cast any desired form of oil grooves. These cores are doweled and screwed to the cover plate *B* which is raised and lowered by the racks *C*. The racks are made of round stock with teeth milled on a flattened surface, and are operated by the lever *D* which turns the pinion *E*. The outside of the bearings is formed in the blocks *F* which are fastened to the plate *G*, and the entire mold is mounted on a cast-iron base *H*. The shrinkage between the flanges will usually cause the castings to stick on the stationary part of the mold and means must be provided for ejecting them. For this purpose ejector plate *I*, which in the casting position rests on four lugs of base *H*, carries an ejector pin located under each flange of the bearing. A nozzle *J* which is tapered inward directs the metal to the side of each bearing, while on the opposite sides, at *K* and *L*, openings about 0.010 inch deep and extending the full length of the bearing should be provided to permit the air to escape from the mold as it is filled.

The operation of the mold is as follows: When the castings solidify, the handle *D* is operated, thereby raising the cover plate *B* about 5 or 6 inches. Further movement causes the strip *M* connecting the racks *C*, to engage and raise the ejector plate *I* and thus eject the finished castings. When the cover plate is lowered again, it strikes against two heavy pins *N* which are mounted on the ejector plate *I*, and the latter is thus brought back to its normal position on the lugs of the base *H*. The mold is then ready for another casting.

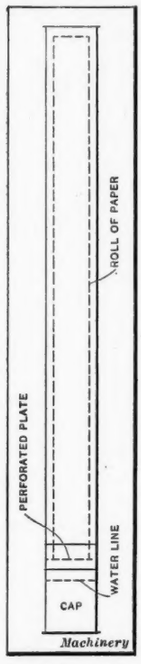
In this form of construction only a small additional expense is involved in producing a mold for making two castings at a time. For example, the space for the outside of the bearings, which is purposely shown on two separate blocks *F*, can readily be machined at the same time by clamping them together for the boring operation. Likewise the two cores *A* can be screwed together for performing the turning and milling operations. And surely the increased production will many times offset the small additional cost of a double mold. In the operation of the mold good results will be obtained if a strong yellow gas flame is directed against the mold from time to time A coat of carbon will be deposited in this way which helps the babbitt to flow more freely. S. SUCRAM

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

RESTORING VAN DYKE PAPER

We had a roll of Van Dyke or black process paper which was not used very frequently and finally became so dry and brittle that it could not be handled. After trying various schemes for restoring it, the following method was found very satisfactory. A tin tube of the kind used for keeping blueprint paper was employed; the cap of this tube was divided into two sections as shown in the accompanying illustration, which were separated by a perforated plate. The lower section of the cap was nearly filled with water, after which the roll of paper was placed endwise on the perforated plate and the tube slipped over it onto the cap. In this way the roll of paper was held in a very humid atmosphere, and after remaining there for thirty-six hours, it was found that the moisture had penetrated the roll and made the paper so pliable that it could be easily handled.



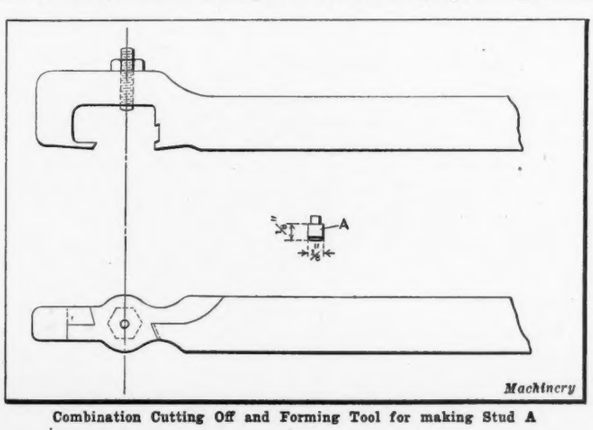
Restoring Van Dyke Paper

Another useful kink for the drafting-room is found in our practice in regard to pencil sketches which are sent out to the shop. It is frequently desirable to retain a copy of these sketches in the drafting-room, and although the originals could be returned, they are sometimes lost and if not lost they are generally so badly soiled that they are hardly worth keeping. We have found it good practice to make carbon copies of all pencil sketches, these copies being preserved in the drafting-room. No extra time is required for this, the only additional expense involved being the cost of the paper. For this purpose unprepared blueprint paper is very satisfactory; it is not costly, and as it is both white and smooth it takes the carbon lines very well. If sheets of carbon paper large enough for the entire drawing are not available, several sheets can be joined with thin adhesive tape. It is a good plan to keep these carbon sheets on hand in sizes to correspond with all the standard sizes of drawings that are used in the shops.

Aurora, Ill. E. J. G. PHILLIPS

COMBINATION CUTTING OFF AND FORMING TOOL

We were called upon to make five hundred small brass studs of the form shown at *A* in the accompanying illustration, and as we did not have a screw machine for this purpose, I devised the tool which forms the subject of this article and used it with very satisfactory results. The tool was made of ⅜-inch drill rod and used in the toolpost of a Rivett lathe. After setting the tool to the proper height and setting the stop on the cross-feed, it was merely a matter of working the cross-feed backward and forward to first form the stud and then cut it off with the two cutters of the tool. After cutting off a finished stud, the bar was advanced until it engaged the stop on the tool, after which the next piece was formed and cut off, the lathe being used in the same way as a hand screw machine. The studs were made of ⅛-inch round brass stock and it was important that their heads should be exactly ⅛ inch in length. By the use of this tool and method of procedure very satisfactory results were obtained.

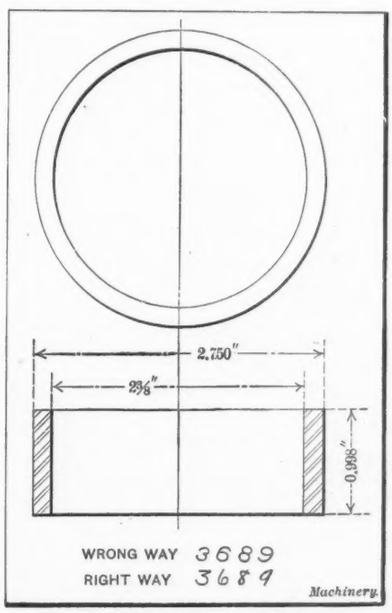


Combination Cutting Off and Forming Tool for making Stud A

Philadelphia, Pa. FRED HENKE

THE RIGHT WAY TO MAKE FIGURES

A short time ago an order went into our shop for a ring to be made in accordance with the design which is presented herewith, but when the work arrived at the inspection table the width was found to be 0.866 inch instead of 0.998 inch, the dimension having been read upside down. While the drawing was theoretically correct, the mistake would not have occurred if the correct reading had been suggested. This incident led us to adopt the following rules in regard to making figures. The 3, 6, 8 and 9 must be made like those in the illustration marked "Right Way"; when made the "Wrong Way," the 3 may be mistaken for an 8 and the 6 and 9 may be read upside down and so mistaken for each other. Furthermore, the 8 made the wrong way is of no assistance in helping one to read the other figures correctly.



Right and Wrong Ways to make Figures

The essential features of the figures made the right way are as follows: The top of the 3 should be sharp instead of round. The 6 should be made with a large curve at the lower left-hand corner, and with a rather small loop which is well away from the initial vertical stroke of the figure. The ends of the 8 should cross each other to avoid confusing the 8 and 3. The 9 should have a sharp point at the top to distinguish it from the 6. With figures that are carefully made in this way it is hard to imagine any confusion in reading them, even if there are no decimal points or inch marks to serve as a guide. The only possibility of error would be in the case of a number made up entirely of ones or noughts, and even in the case of the figure 1 we may add a "hat" and a "pair of shoes," making the figure in the way it appears in ordinary type. It seems, however, that there would be little justification in going to this extreme.

Franklin, Pa. WILLIAM O. MILTON

* * *

The greatest item in the export trade of the United States is raw cotton, which in 1913 amounted to more than half a billion dollars. The next largest item is food stuffs, amounting to $176,000,000; the third largest item is copper, amounting to $100,000,000; and the fourth largest item is oil—petroleum and all its by-products—amounting to $49,000,000.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

MECHANICAL POWERS

H. A. W.—What are the five mechanical powers?

A.—The five mechanical powers were defined in the old books on mechanics as the lever, the screw, the wedge, the inclined plane and the pulley. The wedge, the inclined plane and the screw are essentially one and the same. A screw is simply a cylinder with an inclined plane wrapped around it and, of course, an inclined plane and a wedge are the same. The pulley is but another form of the lever; hence, there are really only two mechanical powers so-called, the lever and the wedge or inclined plane.

STEEL PISTON RINGS

F. W. S.—I am interested in obtaining information relative to the use of packing rings of forged steel for steam engine pistons, and have searched the text-books on machine design and steam engine design, etc. with little reward. I found steel piston rings alluded to in some of the books, but no definite statements of the extent they are used or of the satisfaction they give. Common cast-iron packing rings cause considerable trouble by breaking frequently and cutting the cylinder after they break. I shall appreciate any information that you can give on making forged steel piston rings, their durability, etc.

A.—Steel piston rings are seldom used in stationary steam engines or locomotives, but are used generally in steam hammer pistons, because cast-iron rings are quickly broken by the excessive shocks; it is generally conceded that under usual conditions cast iron is the best material available for piston rings inasmuch as cast iron in contact with cast iron wears better than with steel. However, improved foundry practice has produced a cast iron that wears well in contact with steel, and certain automobile concerns are now building motors in which steel piston rings are successfully used. Steel rings for steam hammer pistons are bent with rollers to the desired circular shape, and after having the ends fastened together either by welding, brazing or pinning, are machined and then cut apart. Any reader having had experience with the making and use of steel piston rings will confer a favor by contributing an article on the subject.

CASTING MONEL METAL

P. J. A. D.—Where can I obtain information on casting monel metal? I have been trying to make monel metal castings 1½ inch by 10 inches long, but without success. The castings, when poured, look fair and solid, but on breaking the skin they are found to be full of blow-holes. The metal melts at high temperature and requires a very refractory sand. I use a mixture of Jersey sand, coarse sharp sand, old crucibles ground up, a small amount of fireclay and flour as a binder, with a little ground coke to make the mold porous. I have taken the precaution to provide a high head and to pour the castings on end. The molds are perfectly baked, well vented and were poured warm, no facing being used on the mold except plumbago.

Answered by E. F. Lake, Detroit, Mich.

As monel metal is a natural alloy made direct from an ore containing nickel, copper and iron, its chemical composition varies considerably. Its nickel content varies from 65 to 75 per cent, copper from 25 to 30 per cent, and iron from 0.40 to 5.25 per cent. This variation in composition causes difficulties that are not encountered when casting alloys with definite compositions. In one case eight propeller wheels were cast and scrapped before a good one was made for one of the battleships of the U. S. navy.

It is difficult to distinguish monel metal from pure nickel, but its cost is considerably lower. This low cost has caused it to be used in many places where non-corrosion is desirable. It is not equal to some other metals and alloys in this regard, but it has considerably more strength and resistance to fatigue than brass or bronze compositions. Its physical properties are about equal to high-grade steel castings. When subjected to a rise in temperature, it loses its strength more slowly than metals ordinarily used. At 1000 degrees F. it has lost only about 20 per cent of its strength. Most metals have lost more than 40 per cent at this temperature, and many of them are practically useless; 1000 degrees F. seems to be a critical point, however, as monel metal rapidly loses its strength after that temperature is passed.

It acts somewhat like steel when it is made into castings and hence many of the same rules are applied. The greatest difficulty encountered is that of blow-holes. The nickel content has the greatest influence on the metal and its melting point is but 160 degrees below that of pure nickel, namely 2480 degrees F.; this is but 70 degrees below the melting temperature of steel. Its high shrinkage, one-quarter inch to the foot, makes it advisable not to have the temperature of the molten metal over 3000 degrees F. when it is poured into the molds. If this temperature falls much below 2800 degrees F. there are likely to be cold-shuts in the mold. While monel metal may be melted in any form of furnace that will withstand these temperatures, an oil-fired furnace gives the best results, providing the fuel is an oil that is low in sulphur. Sulphur has a very injurious effect on monel metal and should be kept as low as possible; so also has an oxidizing atmosphere in the furnace. Thus the flames should be made neutral or reducing.

When the metal is at the right temperature to pour and the crucibles have been taken from the furnace, tongs should be used to push metallic magnesium to the bottom of the bath as quickly as possible. The magnesium should then be well stirred into the molten metal. One and one-half ounce of magnesium should be used for every hundred pounds of monel metal. This must be done each time the monel metal is melted, if blow-holes are to be avoided. The molten metals should then be allowed to stand for a few minutes while the magnesium is impregnating the bath and raising the impurities to the top, so that they can be skimmed off before pouring. Monel metal melts quickly, and when it is poured into the molds it sets rapidly. Castings should therefore be poured on end to insure quick feeding and the maximum amount of pressure from heads and risers.

In the making of molds practically the same rule should be followed that is used in making molds for steel castings. The same sands should be used in order to take care of the high melting temperature and the molds should be constructed so that the gases will leave the solidifying metal as freely as in steel castings. The patterns should have liberal fillets to assist in the flow of metal and to help overcome any defects that might be caused by the contraction due to the high shrinkage.

* * *

HISTORY OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

A history of the American Society of Mechanical Engineers from 1880 to 1914, including the present administration, has been prepared by Prof. F. R. Hutton who was secretary of the society for twenty-four years. The history will contain over two hundred pages 6 by 9 inches and will be illustrated by over fifty photogravures of former presidents and the executive officers, views of the headquarters, etc. The price of the history has been fixed at $5 a volume with the understanding that if over four hundred copies are subscribed for the price per volume will be reduced.

* * *

A contributor of an article recently published in MACHINERY received many letters in regard to it, requesting more information, advice, etc. The contributor was quite willing to give additional information although it involved considerable labor, but he very properly objected to using his own postage for the correspondence. It is always a matter of business courtesy to enclose stamps or a stamped envelope for reply when information is requested of an individual who has nothing to sell and who could expect no profit to result from the correspondence.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

GORTON UNIVERSAL ENGRAVING MACHINE

This is a universal machine adapted for all classes of engraving and profiling which come within its range. It operates on the familiar pantograph principle in which a tracing point at one end of the pantograph follows an accurate "copy" of the design to be engraved, and causes the engraving tool to make an accurate reproduction of this copy to a specified scale. The work-holder may be set at any angle from perpendicular to 15 degrees beyond the horizontal, thus affording an ample range of settings for engraving on various classes of work. The following article explains the method of operation and gives a good idea of the rate at which work can be produced.

In the following description of the universal engraving machine which has recently been placed on the market by the George Gorton Machine Co., Racine, Wis., the method of operation is explained by referring to various examples of tire molds which have been engraved on it. This is quite a natural course to follow, as the machine was primarily developed for the purpose of engraving molds used in the manufacture of automobile, motorcycle and bicycle tires. It must not be assumed, however, that this is in any sense a special tire mold engraving machine, as it is fully universal and adapted for a great variety of engraving and profiling operations of the character met with in die-sinking, toolmaking and certain manufacturing operations. It works on the familiar pantograph principle, as employed in other engraving machines of this company's manufacture, where a tracing pin at one end of the pantograph is guided over a carefully prepared copy of the design which it is desired to reproduce on the work, and the engraving tool at the opposite end of the pantograph accurately reproduces this design. In other Gorton engraving machines the relation of the size of the copy to the size of the work produced may be varied by adjusting the pantograph mechanism, but in the present case the size ratio between the copy and the work is maintained at 3 to 1.

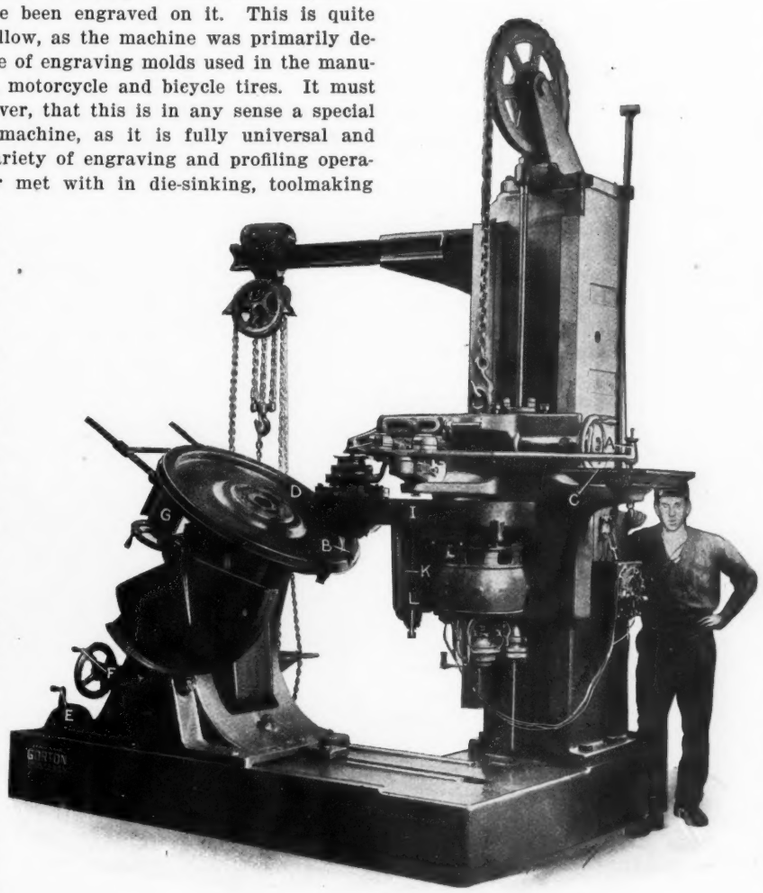


Fig. 1. Gorton Universal Engraving Machine

The engraving machine is shown in Fig. 1, and referring to this illustration the tracing pin will be seen at *A* and the engraving tool at *B;* the copy to be followed is secured to the holder *C*, while the work is clamped to the index-plate *D*. It will be seen that the copy is held horizontally and the workman stands on an adjustable platform—not shown in the illustration—which is at such a height that he can conveniently watch the progress of the tracing pin over the copy. It will be noticed that the index-plate *D* may be set at any convenient angle for handling the work, this angular setting being obtained by the handle *F* which turns the worm and segment. The handle *E* provides for adjusting the position of the work-holder for various diameters.

Fig. 3 shows half of a mold for use in the manufacture of Goodyear "chain tread" tires, which was engraved on the new Gorton machine, and an idea of the rate at which the work can be done will be gathered from the fact that the engraving of the chain was completed in 2½ hours, while the engraving of the nameplate and address of the Gorton Machine Co. required ½ hour. The work is 36 inches in diameter and the depth to which the chain was engraved 3/10 inch. The copy used for this engraving operation and the engraving tools employed are illustrated in Fig. 4. It will be seen that the copy is in three parts which are marked Operation 1, Operation 2 and Operation 3, respectively. The first part of the copy is used for roughing out the impression of two adjacent links. The second part is used for rounding the edges and deepening the cut in the connecting link. The third part is used for rounding the edges of the flat link, *i.e.*, the link the impression of which appears to be lying on its side.

A brief consideration will make it evident that the work must be indexed to bring it under the engraving tool, and means must be provided for moving the engraving tool on the arc of a circle owing to the fact that the mold is concave. The indexing is accomplished by the hand-operated mechanism shown at *G* in Fig. 1. This consists of a drum mounted on a shaft that is turned by the handwheel at its lower end. At the upper end there is a 20-tooth spur pinion—not shown in the illustration—which engages a 480-tooth spur gear secured to the back of the face-plate on which the work is carried. The size of the pinion and gear makes it necessary to turn the handwheel through twenty-four revolutions to obtain one complete revolution of the work. To provide for moving the work through fractional parts of a revolution, the drum *G* has a square thread or helix cut on it, which makes twenty-four complete turns. At the bottom of this thread or helix holes are drilled, a special drum being made for each engraving operation, which has the same number of holes as the number of divisions for which it is required to index. A spring plunger is provided that can be locked up out of engagement with the holes, although it cannot be lifted high enough to clear the thread; and when the plunger is down in one of the holes, it locks the mechanism and work in position for the engraving operation. The reason for this construction is to prevent the possibility of mistakes occurring in indexing.

To explain the operation of the indexing mechanism, sup-

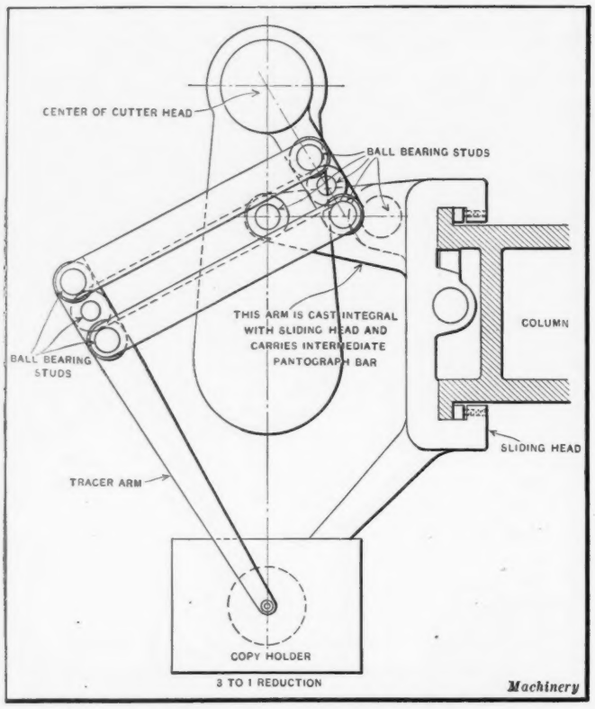


Fig. 2. Arrangement of Pantograph Mechanism for a Fixed Reduction of 3 to 1

pose it is required to engrave fifty "links" in the mold illustrated in Fig. 3. A drum would have to be made for this job with fifty holes equally spaced on the helix. Owing to the nature of the work, the operator cannot see the cutter and he depends on the micrometer collars on the feed-screws to get the required depth. But despite this fact, he must occasionally inspect the work to see that satisfactory results are being obtained, and to facilitate doing so a boy is stationed at the index head to rotate the index-plate and work to bring the section on which the tool was working into view. To do this he lifts the pin out of the hole in the index drum and locks it up so that he can turn the work by rotating the handwheel. When he lifts the index pin out of the hole and before starting to turn the work, the boy sticks a hard wood plug into the hole from which the pin has just been removed. When the inspection has been completed he turns the index plate back quickly to the original position, and the pin which follows the helical groove in the drum hits the wooden plug, breaks it off and drops into the hole, pushing the end of the plug out into the hollow drum. The arrangement is simply a "fool-proof" device that enables a boy to be employed to look after the indexing, thus conserving the time and strength of the machine operator. Without this arrangement it would be difficult to find a station on the index drum after once leaving it, but no difficulty has been experienced in following the method of procedure which has been adopted.

Fig. 3. One-half of a Goodyear "Chain Tread" Tire Mold engraved on Gorton Machine

In engraving tire molds and other classes of work for which this machine is adapted, it is necessary to be able to locate the work at different angles according to the position in which the engraving is being done. For instance, in engraving tire molds the manufacturer's name is engraved in the mold in a position corresponding to the side of the tire, while the cavities in the molds used for making "non-skid" tires are naturally located on the tread. It has already been mentioned that the handle *F* provides for setting the work at the different angles that may be required. For instance, in milling the links in the half mold shown in Fig. 3, the work-holder was set at an angle of 65 degrees. The work-holder is of exceptionally heavy construction and provided with a rotating spindle, on the nose of which faceplates of any required shape or size may be mounted. The faceplate spindle bearings are mounted in trunnions to provide for making the angular adjustments previously referred to, the range of such adjustment being from a vertical position to about 15 degrees beyond the horizontal, the total angular movement provided being sufficient to present any part of the interior of the mold normal to the cutter.

The "copy"—as shown for a chain tread tire mold in Fig. 4—guides the engraving tool in a horizontal plane, but owing to the fact that the mold is concave, means must also be provided for guiding the tool vertically. For this purpose a templet of the proper form is provided, as shown at *H* in Fig. 1. At the top of the spindle in which the engraving tool is

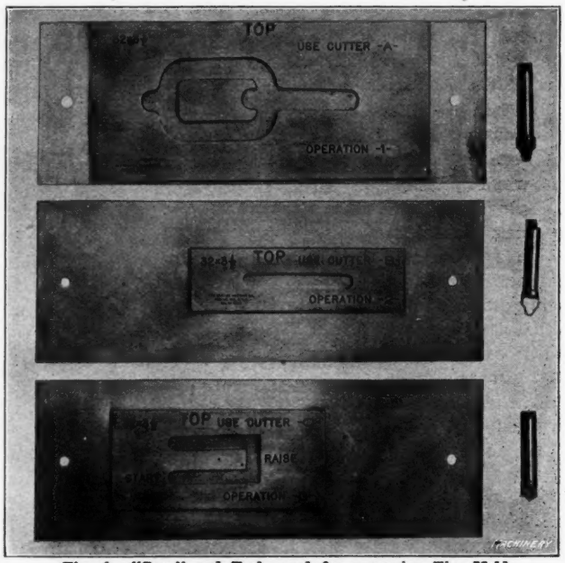


Fig. 4. "Copy" and Tools used for engraving Tire Mold shown in Fig. 3

carried, there is a point which runs over this templet; and in this way the vertical position of the tool is controlled as it is guided over the work by the pantograph. The vertical cutter spindle is mounted in the frame *I* and the motor which drives the spindle is also supported by this frame, the motor being belted to the spindle. The motor and spindle mechanism are supported on the link *K*, which, in turn, is carried by the pivot *L* and a similar pivot on the column slide. These

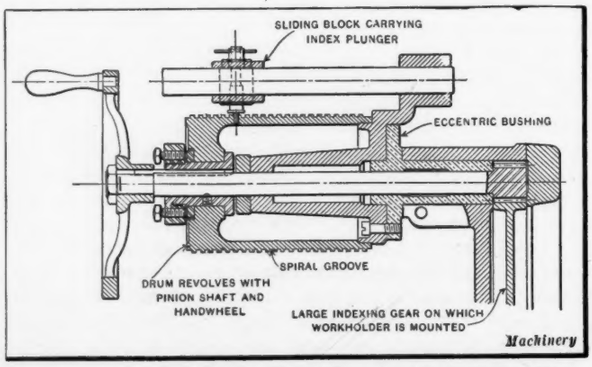

SLIDING BLOCK CARRYING INDEX PLUNGER
ECCENTRIC BUSHING
SPIRAL GROOVE
DRUM REVOLVES WITH PINION SHAFT AND HANDWHEEL
LARGE INDEXING GEAR ON WHICH WORKHOLDER IS MOUNTED
Machinery

Fig. 5. Index Mechanism—a Special Drum is made for Each Job

pantograph pivots are fitted with radial and thrust ball bearings so that the movement is very sensitive.

Figs. 7 and 8 show another form of mold used for forming the treads of rubber tires, which can also be engraved on the new Gorton machine. Here the design is cut on the periphery of a drum and the sheet of rubber for the tread is wrapped tightly around this engraved drum and partially vulcanized. It is then stripped from the drum, reversed and wrapped around the tire foundation and shaped to it, after which the rubber is vulcanized with the tire fabric and firmly cemented to the foundation. The fact that work of this character can be engraved on the same machine as that used for producing molds of the form shown in Figs. 3 and 6 goes to show the wide range of work for which it is adapted.

Fig. 6. "Non-Skid" Tire Mold engraved on Gorton Machine

Fig. 7. Mold for "Diamond Tread" Tire made by forming Rubber before cementing it to Tire Foundation

Fig. 8. Mold for "Non-Skid" Tire when made by forming Rubber before cementing it to Foundation

Bicycle tire molds are made in one piece and while being engraved are held in the fixture shown in Fig. 9. This is not an indexing fixture, and when it is necessary to reset the work, the clamps are loosened for this purpose and the mold is moved around by hand to bring it into position to continue the engraving. As it is impossible to cut all of the design and lettering in a one-piece mold with the work held at any one angle, means are provided for reversing the angle of inclination so that after one side of the mold has been engraved, it may be reversed ready for engraving the opposite side. It will be seen that the clamping ring is mounted on trunnions which are graduated in degrees to provide for obtaining the required angular setting. Each trunnion is provided with a short slide *M* so that the center of the arc of the mold can be made to correspond with the axis of rotation. The circular nuts seen at the outside are provided for the purpose of clamping the trunnions to hold the work in any required position.

Fig. 9. Non-indexing Fixture used for engraving Bicycle Tire Molds

The spindle of the cutter head is driven by a three-horsepower variable speed motor with the controller mounted on the column of the machine, as shown in Fig. 1, and sliding adjustment is provided to maintain the required belt tension. The entire mechanism of the machine is carried by the sliding head which has a vertical adjustment of approximately 4 feet on the scraped ways on the column. The adjustment is regulated by a handwheel which is fitted with a micrometer collar reading to 0.001 inch. The feed-screw has a ball bearing to take the thrust, and the head is counterbalanced by a weight located inside the column, the counterweight being supported by a chain as shown. The column is of box construction and the ways are accurately scraped to surface plates. The height of the column is about 9 feet and the thickness of the walls 1 inch. It will be seen that a small jib crane is provided for use in lifting heavy pieces onto and off of the index plate. The baseplate is a heavy one-piece casting which is heavily ribbed throughout, and the column is secured to this base casting by six 1½-inch bolts. The indexing work-holder is also secured to this base casting and provided with means of adjustment for handling work of various diameters in the manner previously referred to.

A good idea of the capacity of the machine will be gathered from the fact that all types of molds for all sizes of tires up to 48 inches in diameter can be engraved on it. To emphasize the fact that the machine is fully universal in its application, it will not be out of place to mention that it is used for engraving the tire maker's name on the side of the mold and for engraving the impressions for various forms of treads used on non-skid tires. Sufficient power is provided to drive a high-speed steel cutter 1 inch in diameter to the limit of its capacity. In regard to the rate of production, a letter S 1½ inch high was engraved with a ⅜-inch cutter to a depth of 5/16 inch in four minutes, the material in which the engraving was done being a concave forged steel ring. The same letter was engraved in cast iron in 1½ minute. The principal dimensions of the machine are as follows: height, 12 feet, floor space occupied, 5 by 9 feet, and net weight, approximately 18,000 pounds.

DODGE SAFETY CLUTCH

The multiple disk friction clutch which forms the subject of this article is a recent product of the Dodge Mfg. Co., Mishawaka, Ind. The mechanism is completely enclosed so that there are no projecting moving parts to cause accidents by catching the clothing of the workmen. Having the mechanism enclosed in this way provides a perfectly smooth contour, and the use of cumbersome and unsightly makeshift safeguards is eliminated. The design of the roller toggle operating mechanism and the materials used for the multiple friction disks, make this clutch exceptionally powerful for its size. The rollers on the toggle levers travel on conical surfaces which are arranged to give a high driving pressure

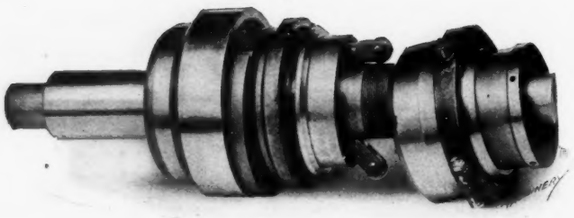


Fig. 1. Parts of Dodge Safety Clutch

on the friction disks with the minimum amount of mechanical friction. The use of rollers in place of sliding parts makes the clutch easy to operate and it is claimed that the action of centrifugal force tends to keep the clutch disengaged when it is thrown out.

The clutch is automatically lubricated by means of an oil ring which revolves in a large reservoir and carries up a continuous supply of oil which is circulated through suitable grooves to all parts of the bearing on which the pulley is mounted. The oil reservoir is completely sealed so that oil cannot work out into the mechanism of the clutch. The shifter ring is made with a channel section which serves to retain the oil and insure positive lubrication at this point at all times. The clutch is easily adjusted by means of a single nut. Backing off this nut permits of the removal of the oper-

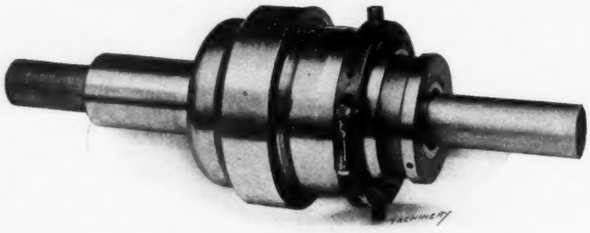


Fig. 2. Dodge Clutch assembled ready for Operation

ating cone to expose the toggle mechanism; and this also permits of the removal of the entire inside mechanism for making adjustments. The clutch occupies only a small amount of space on the shaft and requires very little attention to keep it in a satisfactory working condition. It may be easily applied to stationary or portable tools and is also well adapted for use on countershafts, pulleys, gears, sprockets, etc. The design and construction have been worked out in a way which makes this clutch particularly suitable for high-speed transmissions.

"THOR" ELECTRICAL GRINDER AND DRILLS

The portable electrical grinder illustrated in Fig. 1 is a recent product of the Independent Pneumatic Tool Co., Thor Bldg., Chicago, Ill., and is particularly adapted for grinding castings, polishing, buffing, etc. Reference to the illustration will show that a wheel guard is provided to insure the safety of the operator in the event of a wheel's bursting. The

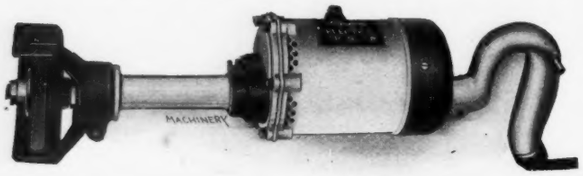


Fig. 1. "Thor" Electrical Grinder

grinder has a free speed of 4500 revolutions per minute; the wheel is 4 inches in diameter by ¾ inch wide and the weight of the tool is only 16 pounds.

In the November, 1913, number of MACHINERY, the No. 000 portable electrical drill of this company's manufacture was illustrated and described. This tool has a capacity for driving drills up to ¼ inch in diameter. Since the publication of the preceding article, the Independent Pneumatic Tool Co. has added to its line four other sizes of electrical drills, the largest of which has a capacity for driving drills up to ⅞ inch in diameter. Fig. 2 illustrates the No. 00 tool which has a capacity for drills up to 5/16 inch; and in Fig. 3 the No. 2 tool is illustrated, the capacity of which is for drills up to ⅞ inch. The drills are equipped throughout with ball and roller bearings.

The motors used on these tools are of the series wound repulsion type, and may be provided for use on either alternating or direct current. The motor is cooled by an aluminum fan which is keyed to the armature shaft and the power is transmitted by a pinion screwed onto the armature spindle. This arrangement enables a new pinion to be easily substituted in case of damage. Different users of these drills require them to run at various speeds, and on this account three sets of gears are manufactured, any one of which may be supplied with the drill to give the high, intermittent or slow speed, as required. A center-plate is placed between the gears and the motor, making it possible for the gears to be packed with grease without the lubricant getting into the motor. This center-plate also takes the end thrust of the spindle. The

Fig. 2. No. 00 "Thor" Electrical Drill

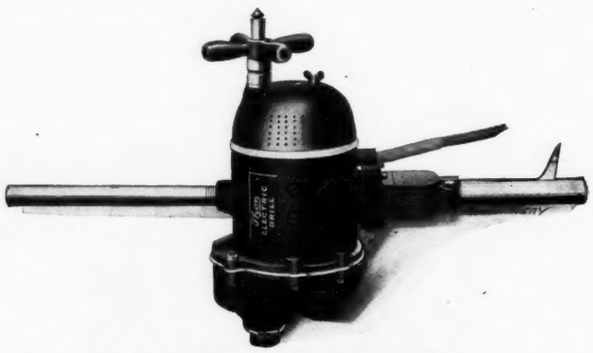


Fig. 3. No. 2 "Thor" Electrical Drill

spindle runs in annular ball bearings which afford the maximum of transmission efficiency and smooth running properties.

ADJUSTABLE RATCHET WRENCH

The Adjustable Ratchet Wrench Co., Room A, 1651 Marquette Bldg., Chicago, Ill., is now manufacturing the "Anderson" adjustable ratchet wrench which is illustrated and described herewith. The jaws of the wrench are opened or closed to fit any size of nut or bolt by the worm in the center, and this means of adjustment eliminates the necessity of having an assortment of different sized wrenches. The ratchet works at either side. This wrench is particularly convenient for use in places where space is limited. It is made in 6-, 8- and 10-inch sizes, with either a plain finish or nickel plated. The material is casehardened drop-forged

"Anderson" Adjustable Ratchet Wrench

steel. Mechanics will find this wrench especially useful in assembling machinery and it will also be found valuable in plants where the machines require frequent adjustment.

J. H. WILLIAMS & CO.'S TOOL-HOLDERS

Reference to the illustrations of these tools will make it evident that the cam fastening for the cutter is one of the important features. The cam used for this purpose has a very gradual rise so that a powerful grip is secured, and difficulties arising from broken set-screws are eliminated. The features of the boring tool are the elimination of the necessity for using bushings with different sizes of bars; and the single cap that serves for holding both straight and angular cutters. The threading tool may be used either as a solid or a spring tool. The planing tool provides fine adjustment and easy means of setting, together with great strength and durability.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., is now manufacturing a line of tool-holders which includes turning, cut-off, side-tool, boring, knurling, threading and planing tools. A great deal of time and experimental work

Fig. 1. Two Forms of Locking Cams used on Turning, Cut-off and Side-tool Holders

has been devoted to the development of this line for the purpose of overcoming all weak points. The holders or shanks are drop-forged from a strong tough grade of steel, after which they are carefully heat-treated to refine the structure of the metal and give it the necessary strength and resistance to wear which is required to successfully meet the class of service performed by the average tool-holder. Those who have had experience in the use of tool-holders in which the cutter is held in place by a set-screw know that trouble is frequently experienced through the breaking of the screw. When this happens it is a difficult matter to remove the broken part of the screw from the holder because the screw is bearing against the cutter and the back pressure locks it in the thread. An investigation of workmen's time cards in

Fig. 2. Turning-tool Holders with Straight Shanks, showing the Two Types of Cams used

many shops has shown that it is not an uncommon occurrence for a man to spend more time on the removal of a broken set-screw than the entire tool-holder is worth. Furthermore, it is often found necessary to anneal the screw

Fig. 3. Cut-off and Side-tool Holders with Right- and Left-hand Offset Shanks

Fig. 4. Boring-tool Holder showing Cutter in Straight and Angular Positions

in order to drill it out, and when this is done the metal in the tool-holder is likely to be damaged so that it will stand up for only a short time when it is again ready for use.

With the view of overcoming the difficulties resulting from the use of set-screws, a carefully designed form of locking cam made of hardened and tempered tool steel has been substituted on the Williams tool-holders. These locking cams have a very gradual rise so that an extremely powerful grip is obtained through the application of a moderate pressure on the wrench with which the cam is turned. These cams are made in two forms as shown in Fig. 1, one of which is provided with a hexagonal head so that it may be turned with the special wrench provided for that purpose or with any other wrench that will fit. The second form of cam has a hexagonal socket and is turned by the same kind of key wrench that is used on the well-known hollow safety set-screws. The cams with the hexagonal head are of the standard form, but the cam with the socket is provided for

Fig. 5. Knurling-tool Holder provided with Coarse, Medium and Fine Knurls

cases where there is not sufficient clearance to admit the head of the cam, an example being the turning of small crankpins and facing the cheeks of the cranks. The two forms of cams are interchangeable in the same holder. Only about 1/12 of a turn is necessary to tighten the cutter in the holder or release it, so it will be evident that the operation is quite rapid. Full freedom of operation is obtained without removing the holder from the toolpost. With the idea of determining the relative strength of the grip obtained with the Williams cam fastening and with the commonly used set-screw, tests were conducted by mounting tool-holders provided with ¼-inch cutters held by the two forms of fastenings in a fixture mounted on a Riehle testing machine and applying pressure to the point of the cutter. It was found that the cutter held by a set-screw could be moved by the application

Fig. 6. Threading-tool Holder with Lockable Spring Head

of a pressure of 2400 pounds, while the cutter held by a cam required the application of 4200 pounds pressure to move it.

Fig. 2 shows the Williams turning tools provided with the two forms of cams and with straight shank holders. Turning tools of this type are also made with both right-hand and left-hand off-set shanks. The holders with straight shanks are made in seven different sizes with capacities for square cutters ranging from ¼ to ¾ inch in size; and the holders with off-set shanks are made in six different sizes with capacities for square cutters from ¼ to ⅝ inch.

Fig. 3 shows a combination tool-holder for cutting-off tools and side-tools. Evidently the provision of a single holder suited for both styles of cutters means a material reduction in the investment in tool-holders which a shop is called upon to make. It will be seen that the broad edge of both the cut-off and the side-tool cutters are at the top. In the case of the cut-off tool this is necessary to provide the required clearance; and in both cases, having the broad edge of the cutter at the top provides more metal behind the cutting point for the purpose of conducting away the heat generated by the cut as rapidly as possible to avoid damaging the cutter. These tool-holders are made with straight shanks with the cutter on the right-hand side, and with right- and left-hand off-set shanks. Both styles of holders are made in five different sizes with capacities for cut-off tools ranging from 3/32 by 5/8 inch up to 3/16 by 1⅛ inch in size; and for side-

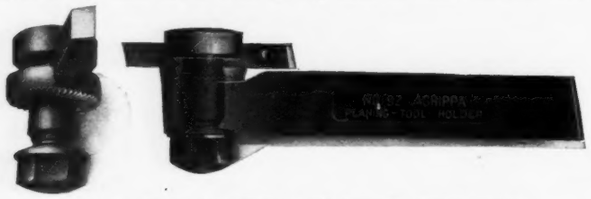


Fig. 7. Planing-tool Holder with Serrated Washer which affords Fine Adjustment

tools ranging from 5/32 by 5/8 inch up to 3/8 by 1⅛ inch.

The distinctive features of the new Williams boring-tool holder are that the same holder can be used for all sizes of boring-bars which come within its range without requiring the use of bushings or shims; and that the cutter can be supported in the sleeve bar in a straight or angular position without requiring the use of more than one cap. Reference to Fig. 4 will make these features quite clear. The shank is provided with a shoulder in which there is a groove which receives the boring-bar, the bar being held in place by a cap and two screws. The larger sizes of bars are held as shown in the illustration, but when the bar is so small that the cap contacts with the holder, the cap must be removed and replaced in the reverse position so that the slot in the top engages the bar. Fig. 4 shows quite clearly the way in which the cutter may be held in the bar in either a straight position or at an angle. Reference to this illustration will also show that there is a tapped hole in the end of the bar, which receives the clamping bolt. This bolt has two holes through it to accommodate the cutter in either of the two positions in which it is used. A sleeve with corresponding holes abuts against the end of the bar and the cutter is slipped through these holes in the sleeve and clamp bolt, after which the bolt is tightened to secure the cutter in place. These boring-bars are made in four sizes with capacities for all sizes of bars ranging from 3/16 inch in diameter to 1⅛ inch in diameter. This tool-holder holds either round, hexagonal or octagon bars with an equally efficient grip, the clamp securing a four-point contact on bars of any of these shapes. A plain solid bar with straight and angular cutters at opposite ends is also provided for use in connection with these holders.

Fig. 5 shows the Williams knurling tool which is fitted with three pairs of knurls carried in a revolving head. These knurls provide for handling coarse, medium and fine work, and any set of these knurls may be instantly brought into the operating position by revolving the head. It will be seen that there is a hole in the side of the holder, which is for the purpose of enabling the pins to be driven out when it is desired to put new knurls in the holder. The knurls and the pins on which they revolve are made of carefully heat-treated tool steel. The size of the shank of this holder is ½ by 1⅛ inch by 6⅝ inches, and the size of the standard knurls is 3/16 by ¾ inch.

The distinctive feature of the threading tool-holder shown in Fig. 6 is the provision of a lockable spring head which provides a solid head for the holder when used for taking heavy roughing cuts, after which the lock may be loosened to provide for taking the finishing cut. The lock by which this result is secured consists of a bolt, the head and nut of which have an annular V-groove cut on the inside. These grooves fit over corresponding V-bearings on the holder and when the bolt is tightened it locks the spring head of the holder so that it is perfectly rigid. When it is desired to use the holder as a spring tool for finishing operations, it is merely necessary to loosen the bolt through part of a turn. The cutter is held in place by the form of locking cam which has already been described in detail. This tool is adapted for all classes of threading operations from the coarsest to the finest, and its lockable spring head is also especially well adapted for other classes of lathe work. These holders are made in three sizes with capacities for square cutters, ¼, 5/16 and ⅜ inch in size, respectively.

Two noteworthy advantages are secured by the use of a separate serrated adjustment ring in connection with the Williams planing-tool holder. First, the serrated ring provides twenty-eight positions in which the cutter may be set, so that any desired adjustment may be obtained without the necessity of grinding the tool. Second, the ring may be made sufficiently hard so that the pressure of the cut will not result in the cutter wearing down its bearing so that the entire holder becomes worthless; and the use of a separate ring allows the remainder of the holder to be left soft so that it possesses the necessary strength to resist the intermittent strains which would be likely to result in breaking the holder at the neck, if the entire shank were hardened to provide the necessary durability for the cutter bearing. Another feature is that the serrated adjustment ring makes it only necessary to turn the nut on the locking bolt through a half turn in order to loosen it sufficiently to adjust the position of the cutter. Reference to Fig. 7 will show that the washer under the nut on the locking bolt is provided with a spherical bearing on its under side. This permits the bolt to adjust its position to compensate for the strain of the cut without any tendency to bend the bolt and introduce transverse stresses in it. Either square or rectangular cutters may be used. In addition to its use as a planing tool, this tool is especially adapted for use on the heavier classes of lathe work—particularly those classes of work where off-set tools are required. The holder is made in six different sizes with capacities for cutters ranging from 5/16 by 7/16 inch up to ⅞ by 1⅛ inch in size.

BOSTON GEAR GAGES

To meet the requirements of inspectors, designers and others who need accurate means of testing the accuracy of gear teeth, the Boston Gear Works, Norfolk Downs, Mass., has developed the set of rack type gear gages which are illustrated herewith. It is claimed that the rack type of gage

Boston Steel Gear Gages

is preferable to the circular gage for the following reasons: First, greater accuracy is obtained when the gage is in the form of a rack; second, there are more teeth in contact while testing and it is possible to roll the gear in contact with the gage; third, the circular pitch of the rack type of gage can be tested with great accuracy.

This set of gear gages comprises fourteen individual gages which provide for measuring twenty-two standard diametral pitches. The pitches provided in the standard set of gages are as follows: 6, 7, 8, 9, 10, 11, 12, 14, 16, 18, 20, 22, 24, 26,

28, 30, 32, 36, 40, 48, 64 and 80. Reference to the illustration will show that individual gages with teeth cut on only one side are provided for pitches from 6 to 11, inclusive. For pitches ranging from 12 to 80 by the steps already referred to, teeth are cut on both edges of the gage so that each gage provides for measuring two different pitches.

In addition to the standard set shown in the illustration, the Boston Gear Works is making gages of this type in 5, 4 and 3 diametral pitch; and in ¼, ⅜, ½, ¾, 1 and 1½-inch stub-tooth circular pitches. These special gages are all made with teeth on only one side—as in the case of the 6-pitch gage of the standard set.

MARVIN & CASLER BORING HEADS

In the March, 1909, number of MACHINERY the eccentric boring head of this company's manufacture was illustrated and described. Since that time the demand has arisen for smaller boring heads of similar design, and to meet this demand the models C and D heads which form the subject of this article have been developed. The reduction in size of these heads necessitated the substitution of a new method of holding the tool in place of the drill chuck formerly used.

On the style C head which is illustrated in Fig. 1, a hardened V-block and set-screws are provided for holding the tool, two set-screws being used which insures holding the tool

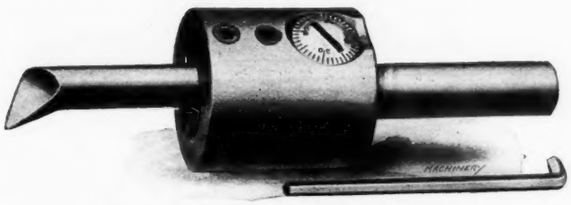


Fig. 1. Marvin & Casler Style C Boring Head

quite rigidly. The V-block is carefully aligned so that twist drills within the range of the chuck can be brought to run true by centering with the micrometer screw. A take-up ring is provided which keeps the moving parts in close contact. This tool has a capacity for drills or other tools with shanks ranging from 3/16 to 3/8 inch in diameter, and the available offset is ⅛ inch.

The style D head illustrated in Fig. 2 consists of a shank and body across which the head is moved which carries the boring tool. The offset adjustment is secured by two opposing hollow set-screws which bear against a cone-shaped extension on the head. The adjusting screws are set at the proper angle for the cone on which they bear and act similarly to a gib, drawing the head up firmly against the outer face of the body in addition to locking the head and tool in place for the

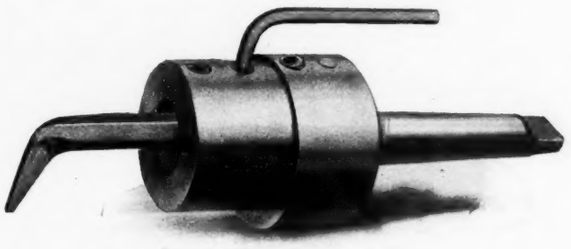


Fig. 2. Style D Marvin & Casler Boring Head

required depth of cut. In setting the tool for any required depth of cut, one of the opposing screws is released and the opposite screw tightened up until the proper position has been obtained. The tool is held in a V-block by two set-screws. This style of chuck is made in two sizes, one of which has a capacity for tools with shanks ranging from 3/16 to ⅜ inch and an offset of ¼ inch, while the other has a capacity for tools with shanks ranging from ¼ to ¾ inch in diameter and an offset of ½ inch. These boring heads are manufactured by the Marvin & Casler Co., Canastota, N. Y.

SLOCOMB BENCH MICROMETER

The J. T. Slocomb Co., Providence, R. I., is now manufacturing a bench micrometer which has a range of from 0 to 6 inches, and is provided with two interchangeable measuring heads. The micrometer is illustrated in Fig. 1 and an enlarged view of the two measuring heads is shown in Fig. 2. One of these heads is graduated to give readings to 0.0001 inch directly from the thimble. This head is provided

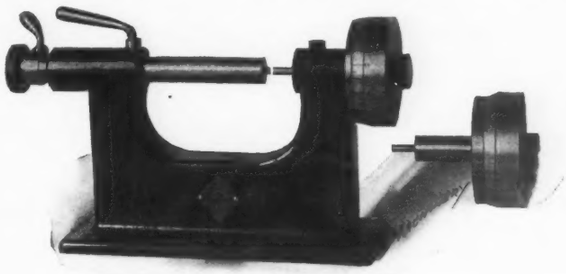


Fig. 1. J. T. Slocomb 6-inch Bench Micrometer

with a very accurate screw and is suitable for use in making gages or for any work where exceptionally fine measurements must be made. The other head has a 10-pitch screw and is graduated to read directly to 0.001 inch, this head being intended for use where rapid measurements must be made, and the graduations are spaced far enough apart so that the readings may be accurately estimated to 0.00025 inch. It makes a useful caliper for tool-work or fitting where frequent measurements must be made.

In both heads the thimble is 4 inches in diameter, and the 10-pitch screw of the second head referred to makes all readings direct, it being merely necessary to take the first figure from the sleeve and the remainder of the reading from the graduations on the thimble. As shown in Fig. 2, the reading of this head is 0.78125. The anvil is made with a sliding bar which is held by a split clamp in the main bed or frame.

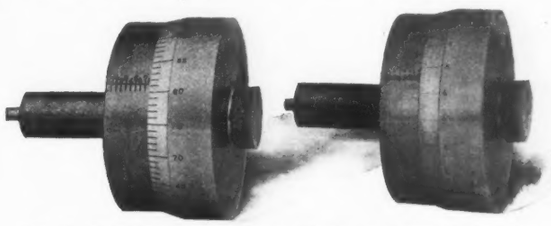


Fig. 2. Interchangeable Measuring Heads for Slocomb Micrometer shown in Fig. 1

This is used for approximate adjustments and has a maximum movement of 5 inches. A fine adjustment is made through the center of this bar, using the knurled headed screw shown at the left-hand end. There is a plunger in this bar which is held back against the adjusting screw by a coiled spring, and a key prevents the anvil from revolving.

GOULD & EBERHARDT BEVEL GEAR ROUGHING SHAPER

The multiple spindle bevel gear roughing shaper, opposite sides of which are illustrated in Figs. 1 and 2, is now being manufactured by Gould & Eberhardt, Newark, N. J. As its name implies, the function of this machine is to take a roughing or stocking cut on both gears preparatory to finishing them on a bevel gear planer. As the stocking cut consumes a large percentage of the time involved in cutting a bevel gear on a gear planer and because this type of machine is far more expensive than a roughing shaper, it will be evident that it is more economical to take the roughing cut on a shaper and then finish the gear on the gear planer. A further advantage of this procedure is that the expensive finishing planer is relieved of the severe strains incident to taking the stocking cut. The Gould & Eberhardt roughing shaper is particularly adapted for roughing out steel bevel gears for

automobile differentials. These gears have projecting hubs on the small end which prevent their being roughed out with the ordinary disk type of gear cutter, as the rotary cutter would not be able to work over the entire face of the gear owing to the interference of the hub with the cutter.

Reference to the illustrations will make it evident that the design of the shaper has been developed in such a way that either one or two bevel gear blanks may be worked on at a time. These blanks are held at the proper angle and indexed at every return stroke of the ram while the shaper head is automatically fed down at each stroke until the proper depth of cut has been reached. The feed is then automatically disengaged and the blank removed from the arbor. This machine is designed to run at 100 strokes per minute. The most important feature of the design is the improved style of head which is equipped with an efficient cam feed mechanism. In the previous design of bevel gear roughing shaper built by this company, the vertical feed of the head was operated by a feed-screw, but in the present construction the feed-screw has been eliminated, as it has been found that the cutting stresses are better controlled by the cam feed mechanism. This new construction also allows the amount of feed to be varied according to the location of the cutting tool in the blank, *i. e.*, when the cutting tool is just entering the blank the maximum feed is employed and as the tool is gradually fed deeper into the blank the rate of feed is decreased. This not only relieves the machine and tool of the heavy strain to which they would be subjected if a constant vertical feed were employed, but it also produces a finer finish on the work.

In general the construction of this machine is that of the high-duty shaper built by this company. The regular cross-head slide and table have been removed and a special work-head substituted in their place, which is provided with the indexing mechanism previously referred to. This work-head may be arranged to cut one or two gears at a time, and suitable means are provided for holding the blanks and lubricating the cutting tools. The illustration shows the machine roughing out two nickel steel gear blanks which have twenty stub teeth of 5/7 pitch. The time required to do this work is three minutes for each gear. It will be seen that these gears have projecting hubs of the form which has already been referred to, and to remove the chips that accumulate between the projecting hub and the inside of the face, two hook tools have been provided that fit in the grooves under spring tension and which may be easily thrown out of position when taking off the finished gears. The indexing of the work from one tooth to the next consecutive tooth takes place when the ram reaches the end of its return stroke, *i.e.*, when the tool is clear of the work. After the indexing operation has taken place and before the tool engages the work for the next cut, the work-spindle is automatically locked so that the blank is securely held in place. While the ram is returning and the tool is idle, the automatic vertical feed of the head takes place; and this feed continues to operate until the feed cam has made one revolution. In revolving, the cam comes to the point where the feed is started and then the head moves back from the work ready to start on another set of gear blanks.

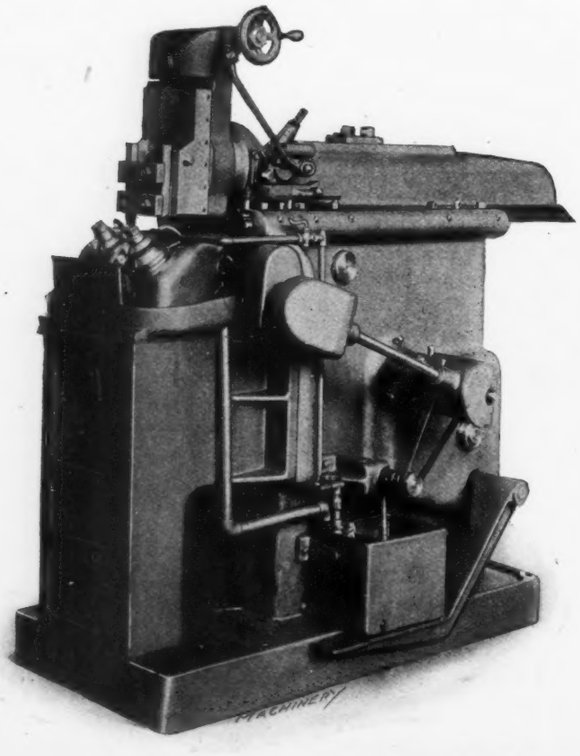


Fig. 1. Gould & Eberhardt Bevel Gear Roughing Shaper

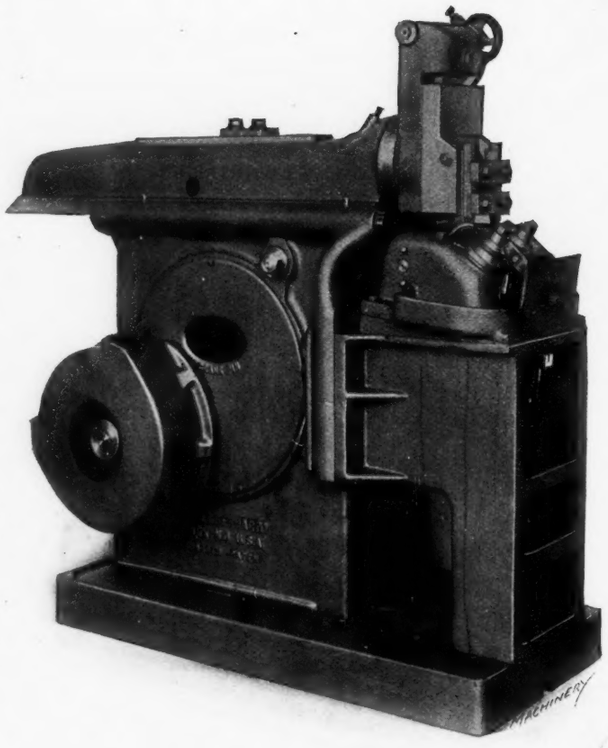


Fig. 2. Opposite Side of Gould & Eberhardt Shaper shown in Fig. 1

KIMBLE ADJUSTABLE SPEED MOTOR

The most important feature of this motor, as concerns its application for driving machine tools, is that the speed may be adjusted by infinitesimally small steps. This adjustment of speed is made by a handwheel mounted on the machine, which makes connection with the motor governor through a shaft or chain. Dynamic braking is employed to produce a quick stop, the action being very powerful. These motors are made in sizes from 1/6 to 2 horsepower, and all sizes are equipped with S. K. F. ball bearings.

The Kimble Electric Co., 2406 W. Erie St., Chicago, has developed a new adjustable speed single-phase alternating-current motor, which has the unique features of being adjustable by the smallest of graduations and of holding its speed within a few per cent of the set value under loads that vary all the way from no load to full load. In this motor the operator adjusts the speed by means of a handwheel connected by shaft or chain to a governor located on the motor. In the case of a lathe drive, the handwheel is placed on the front of the lathe below the headstock, and the start, stop and reverse lever is carried along on the apron. The range of speed is regularly 3 to 1, as 600 to 1800, or 700 to 2100, or 800 to 2400; but in the smaller motor a range of 6 to 1, as from 600 to 3600 revolutions per minute is readily obtained. The speed adjustment is by extremely small steps, any speed whatever within the range being obtainable. The control is

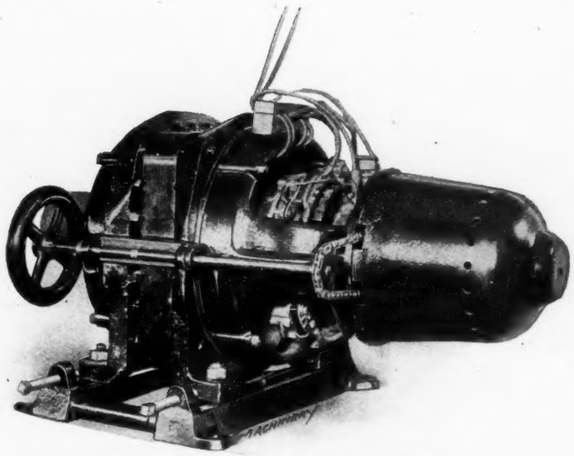


Fig. 1. Kimble Adjustable-speed Single-phase Alternating-current Motor

said to be even more accurate than that obtainable with a direct-current field control motor.

The motor in some respects resembles the direct-current multi-voltage control motor (with an infinitely large number of working voltages) in which the power capacity increases with increasing speed, rather than the direct-current field control motor in which the power capacity does not increase with increasing speed. The motor will deliver its rated horsepower at any running speed, but will deliver more than the rated horsepower at the higher speeds, with the speed drop from no load to full load not over 2 per cent. The motor will deliver its full rating at the lowest speed, but the speed drop from no load to full load may increase to 5 per cent when running at the lowest rated speed. The results obtained with respect to accurate speed control are unique for alternating-current motors, and it is claimed that they can be favorably compared with the best obtainable with direct-current motors.

Dynamic braking is used to produce a quick stop, the braking action being extremely rapid. It differs from that used in direct-current motors in that the turning over of the motor by hand at a low speed does not bring the brake into action. Thus when chucking a piece in a lathe, the spindle can be turned by hand without encountering the slightest resistance from the dynamic brake. In the sizes of ¾ horsepower and above, an outside controller is furnished for bringing the forward or reverse of the motor, or the dynamic brake, into action. In the smaller sizes a double-pole double-throw switch is furnished instead of the controller.

The motor is furnished with or without a mounting; and if without the mounting, the equipment includes slide-rails, a pulley, the speed adjusting handwheel mounted on the motor, and either the outside controller or switch depending on the size. The motor may also be furnished with two types of mounting, either being well adapted for use in driving a lathe or similar machine. On one type the motor is set on slide-rails on a flat topped pedestal fastened to the floor, the controller box being on the side of the pedestal; and the space within the pedestal body is provided with shelves for the storage of tools, etc. The motor is belted to the largest or next largest cone step, this with the back-gear giving every speed required. This arrangement has the advantage of keeping all motor vibration away from the lathe. In the other type of mounting, the motor is carried on the rear side of a swinging frame, the lower end of which is attached

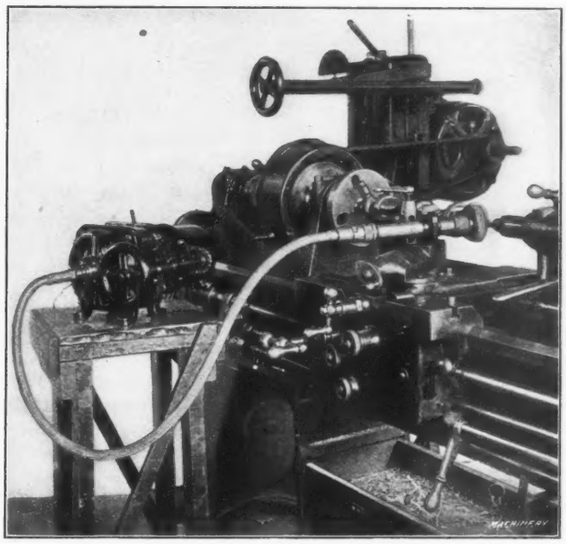


Fig. 3. Motor provided with Flexible Shaft for driving Grinder Head

by a hinge to the floor, so that the whole assembly may be swung away from or toward the lathe to adjust the belt tension. This adjustment is made by a distance piece of adjustable length. The controller box is mounted on the front of the frame. This type of mounting is more compact than the other. With either type of mounting the following attachments are included with the motor: the sprocket, chain, speed adjusting wheel, shaft and bracket, two start, stop, and reverse levers with the shaft and brackets for attaching them to the apron and frame of the lathe, and the connecting link that goes between the apron and controller.

The motor may also be furnished with a standard length of flexible shaft with which a grinder head, buffing head, or drill chuck may be used. These motors are made at present in sizes from 1/6 to 2 horsepower, inclusive, the standard speed range being 600 to 1800 revolutions per minute for all sizes, and this range can be extended if desired. All sizes are equipped with S. K. F. ball bearings. The motor can be used on any machine application requiring adjustable speed; such as lathes, drill presses, milling machines,

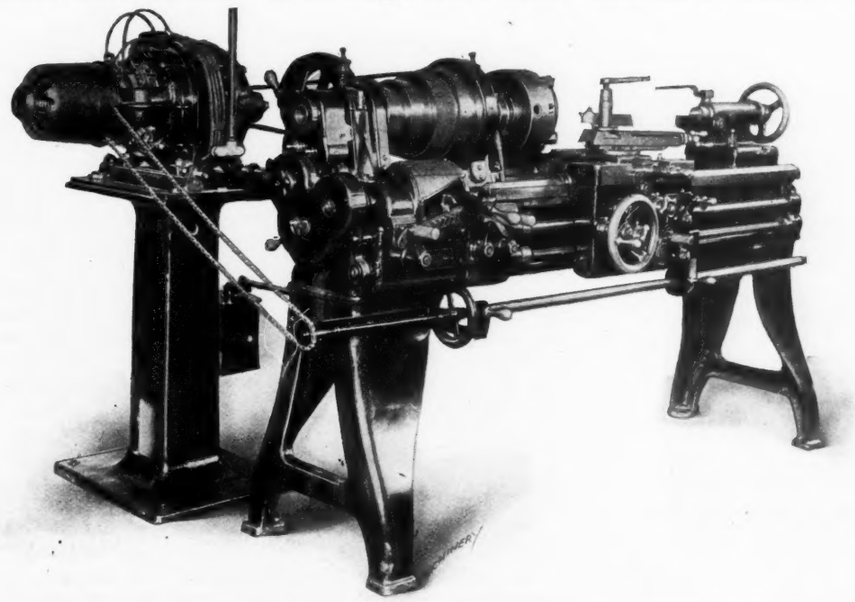


Fig. 2. Application of Kimble Motor for driving Engine Lathe, with Motor mounted on Pedestal

grinders, and other machine tools, as well as many other classes of machinery.

SMITH TRIPLE-BIT SCREW-DRIVER

It will be evident from the accompanying illustrations that the noteworthy feature of the Smith No. 612 "Perfect Handle" screw-driver which forms the subject of this article is the provision of the two auxiliary side bits. These adapt the screw-driver for turning screws in closely confined places where lack of clearance makes it impossible to use the tool in the ordinary way. In addition, the regular bit on the end of the screw-driver can be used in the usual manner.

It will be seen that the screw-driver is one solid piece which is of carefully tempered drop-forged steel. The wooden handle is waterproofed and rests solidly against the steel, the metal protecting the handle at each end so that it cannot

Fig. 1. Smith Triple-bit Screw-driver

Fig. 2. Opposite Side of Smith Screw-driver shown in Fig. 1

be readily damaged. The length of this screw-driver is 9 inches over-all, and the blade is 5 inches long. The bits are 3/8 inch wide by 1/16 inch thick and the shank is 1/2 by 3/8 inch in size. This screw-driver is a recent product of H. D. Smith & Co., Plantsville, Conn.

OHIO EXPANSION SHELL REAMER

Standard practice in toolmaking requires the cutting end of a machine reamer to be somewhat larger than the rear end, thus producing a "back taper" to afford the proper clearance. It is also well known that the cutting end of such a reamer wears more rapidly than portions of the tool nearer the back. With the view of producing an adjustable reamer the action of which will very nearly approach that of a solid reamer, and to enable the reamer to expand most at the point of maximum wear, so that it need not be ground after adjustment, the Ohio Reamer Co., 5337 St. Clair Ave., Cleveland, Ohio, has placed on the market the tool shown in Fig. 1.

The adjusting mechanism consists of a cone on which under-cut threads are machined. The form of these threads is illustrated in Fig. 2, from which it will be seen that the cone cannot move outward because one side of the threads is inclined toward the horizontal axis of the reamer. For a similar reason, the prongs on which the cutting edges of the reamer are carried cannot move out from the axis of the tool and dig into the work. It is claimed that the adjusting mechanism locks the reamer so that no screws, clamps, etc., are needed to make it tight after making the adjustment. The adjustment can be made without removing the tool from the machine in which it is used. An important feature is that the necessity of taking the reamer to the tool-room for adjustment and grinding is avoided, thus overcoming loss of time by the workman and having the machine standing idle.

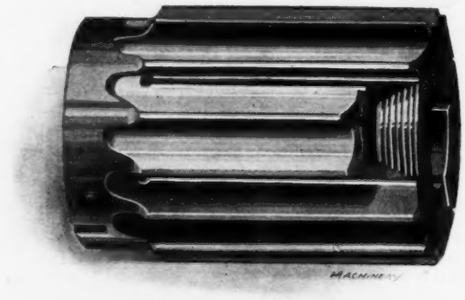


Fig. 1. Ohio Expanding Chucking Reamer

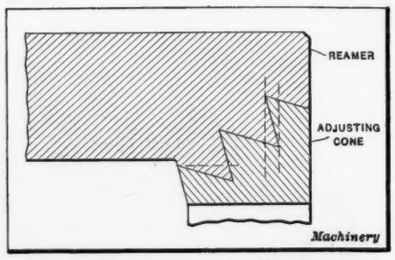
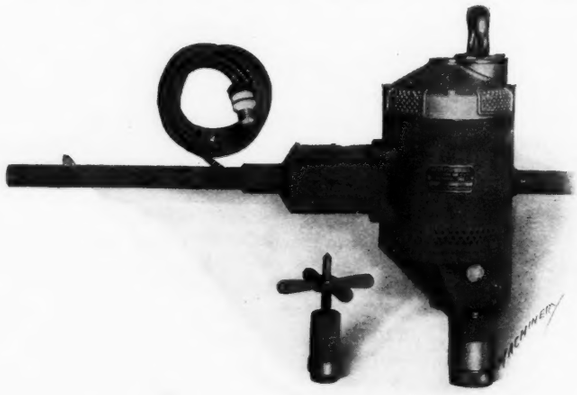


Fig. 2. Means of adjusting Ohio Reamer

CINCINNATI HEAVY-DUTY ELECTRICAL REAMER

The Cincinnati Electrical Tool Co., Cincinnati, Ohio, has recently added to its line of portable electrical drills and grinders the heavy-duty reamer which is shown in the accompanying illustration. This tool is particularly designed for bridge and other structural work, in addition to its use in shops. It is made in three sizes with capacities for reaming holes up to 15/16, 1 1/16 and 1 3/16 inch, respectively. A special type of slip socket is provided which does away with the use of a drift key and drift hole in the spindle.

The motor which is wound for direct current is of the series four-pole type and is fully enclosed. It is air cooled by a fan mounted on the armature shaft. The gears are made of chrome nickel steel and mounted on roller bearings.



Cincinnati Heavy-duty Electrical Reamer

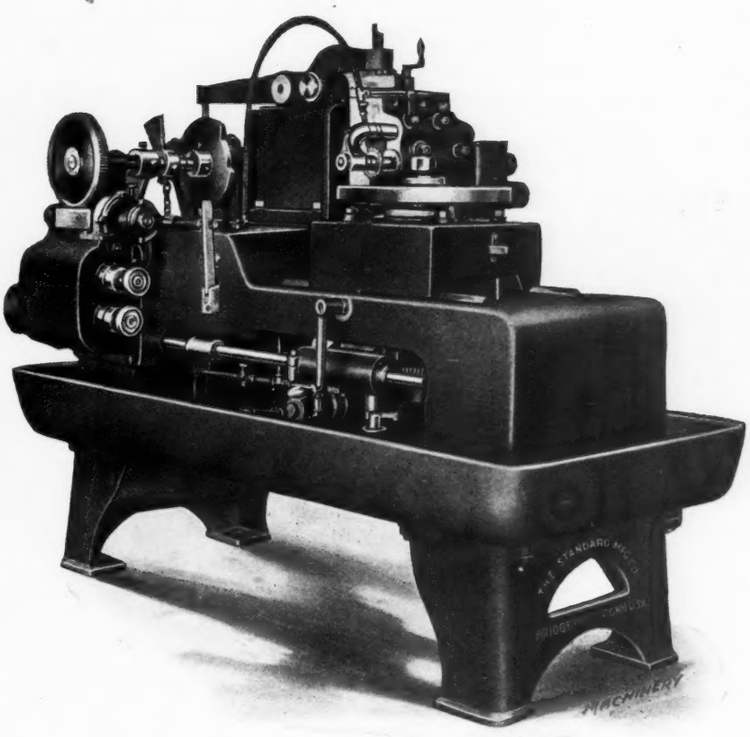
They are fully enclosed in a case at the lower end of the reamer and are packed in grease. A plate separates the gear-box from the motor housing to prevent oil and grease from getting into the windings. Annular ball bearings are used at both ends of the armature shaft and the spindle thrust is taken by a ball thrust bearing.

The switch is of the quick make-and-break type and there is a release lever in one of the side handles. The brush holders are mounted on fiber blocks and are carefully insulated. The binding posts which hold the leads are designed to secure contact by means of compression springs, thus entirely eliminating the use of nuts and screws which may give trouble by working loose and getting into the motor. The brushes are readily accessible through four removable guards and can be instantly replaced without disturbing any part of the tool.

STANDARD DIAL MILLING MACHINE

The dial milling machine illustrated and described herewith is a recent addition to the line of machines built by the Standard Mfg. Co., Bridgeport, Conn. This machine is arranged for single pulley drive and there are eight changes of speed and ten changes of feed. These are obtained through

gear-boxes. The machine is adapted for dials ranging from 7 to 24 inches in diameter, the work-table being adjusted longitudinally on the ways by means of a crank-operated rack and pinion. In this way the work may readily be brought into any desired position. The cutter is raised clear of the dial on the return stroke to avoid having it pass backward through the work. The indexing is accomplished by a worm and worm-wheel, the operation being performed during the return stroke of the cutter. The depth of cut is regulated by a micrometer adjustment and adequate lubrication for the cutter is provided.



Standard Dial Milling Machine adapted for Dials from 7 to 24 Inches in Diameter

limits of all motions.

These machines—like all the milling machines of this company's manufacture—are equipped with a special belt shifting device which provides for moving the belt from one step on the cone pulley to the adjacent step by one turn of a handwheel. This device was described in detail in the October, 1913, number of MACHINERY. Another important feature is the exceptionally rigid construction of all parts where vibration may develop. The column and base are cast in one piece with an unusually heavy front wall forming the slide for the knee and the main support for the spindle.

Ample power is provided by the unusually large cone pulley on the machine. To insure efficient transmission, the spindle is arranged with positive drive for the arbor by means of an interlocking recess and flat. The spindle runs in bronze bearings which are lubricated from oil wells in the column. The double back-gears are eccentrically mounted on the inside of the column below the spindle. These gears are cut with single-purpose cutters and run noiselessly under all conditions. The feed is transmitted from the spindle by a roller chain which makes connection with the feed-box where all changes are controlled. From this feed-box the motion is transmitted through a universal joint and telescopic shaft to a tumbler in the knee which is provided for the purpose of reversing all feeds. From this point the power is transmitted to the table, saddle and elevating screws. All control levers are centralized for the sake of convenience.

OESTERLEIN MILLING MACHINES

The most important feature of the Nos. 34 heavy and 42 plain milling machines built by the Oesterlein Machine Co., Cincinnati, Ohio, which are illustrated and described herewith, is the provision of quick power movements of the knee, saddle and table. These are merely "fleeting" motions for use in connection with whatever feed may be engaged, and are operated by depressing the treadle at either side of the machine. These treadles make connection with a clutch at the rear of the machine which is normally engaged with a gear driven from the feed-box. When the treadle is depressed, the clutch engages with the quick speed derived from the countershaft or lineshaft; and the clutch automatically re-engages the gear driven from the feed-box when the treadle is released. A safety stop is provided at the

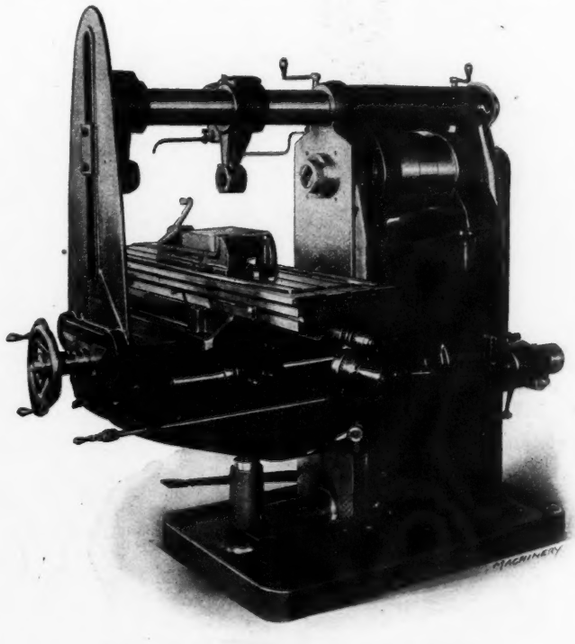


Fig. 1. Oesterlein No. 42 Plain Milling Machine

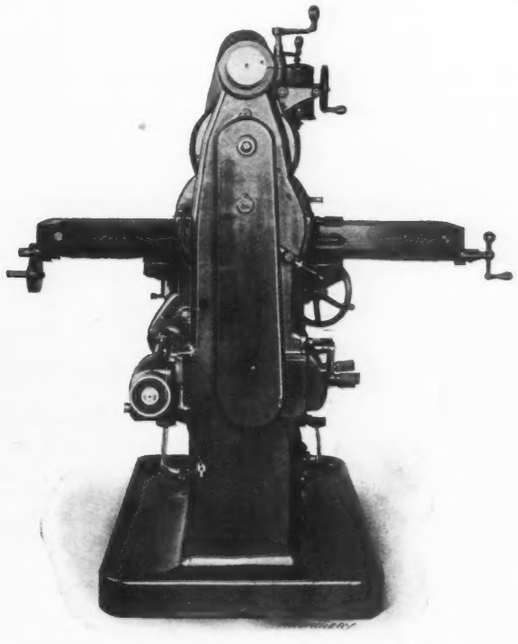


Fig. 2. Rear View of Oesterlein Milling Machine

DILLON MOTOR-DRIVEN GRINDER

The motor-driven grinder shown in the accompanying illustration is a recent product of the Dillon Electric Co., Canton, Ohio. This machine is adapted for use in tool-rooms, and for tool grinding and a variety of other operations in machine shops, where the power requirements are within the

Dillon Motor-driven Grinder

capacity of the motor. The motor is rated at ½ horsepower continuous duty and its momentary capacity will be from 2 to 2½ horsepower. The motor was especially designed for driving this grinder, which is a point that will commend the machine to the experienced man. It is completely enclosed and dust-proof, the construction being particularly rugged to withstand heavy momentary overloads. The motor is controlled by means of a carefully insulated snap switch which is mounted on the pedestal. Motors are provided for use on 110 or 220 volt direct-current circuits, and for 110, 220, 440 or 550 volt 60-cycle alternating-current circuits of either 1, 2 or 3 phase. The dust-proof feature has been so successfully provided for that it is said that bearing troubles are practically eliminated.

The spindle runs in S. K. F. ball bearings and is made of high carbon steel. In addition to the increased transmission efficiency obtained through the use of ball bearings, the improvement of true running properties of the wheels as compared with a machine using plain bearings is very marked. The wheel guards are of heavy construction and they are designed in a way which affords protection to the eyes of the operators from flying particles in addition to protection from accidents resulting from the possible bursting of a wheel. The guards enclose approximately one-half of the circumference of the wheels, as well as both sides down almost to the spindle.

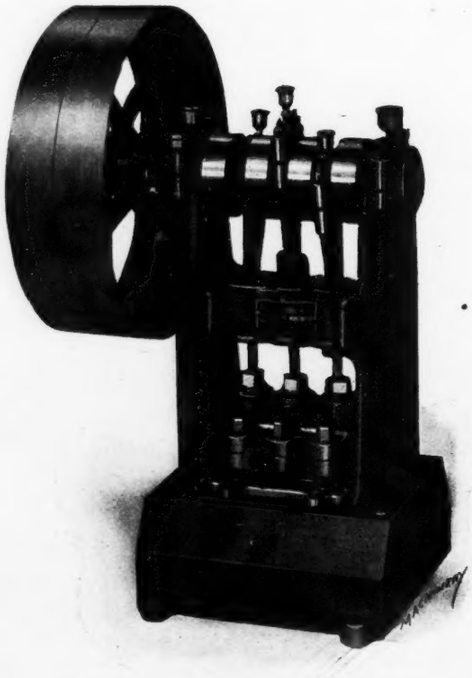
The grinding rests have broad lips in the front and at the outside of the wheels, the construction giving great strength and rigidity. The rests are fastened to the pedestal by means of two bolts passing through slots which provide adjustment for radial wearing of the wheels. The principal dimensions of the machine are as follows: distance between centers of wheels, 26 inches; height from floor to center of spindle, 39¼ inches; diameter of base, 17 inches; size of wheels, 7 by 1½ inch; speed, 3400 revolutions per minute, and net weight of machine, 300 pounds.

HYDRAULIC SINGLE-ACTING TRIPLEX PUMP

To meet the demand for a hydraulic pump delivering a small quantity of water, which is still capable of exerting a high pressure upon the press ram, the pump illustrated and described herewith has been developed by the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. On account of its light weight this pump, when motor driven, may also be mounted on a truck and used as a portable unit for operating small hydraulic shop tools on which no pump is mounted. It is provided with a knock-out attachment which automatically cuts off the delivery of water to the press ram but holds the pressure thereon, when the predetermined maximum pressure is reached. A slight drop in the pressure automatically starts the flow which continues until the maximum pressure is again reached. The base of the pump forms a reservoir for the liquid used in the operation. The pump is built for either gear, chain or belt drive.

The design of this pump is such that any one of twelve different sized plungers may be furnished. These range in size from 3/16 inch to 1 inch in diameter, advancing by increments of 1/16 inch. They are capable of exerting a maximum pressure ranging from 750 pounds to 8000 pounds per square inch; the larger the plunger diameter, the lower is the pressure capacity. It is a single pressure pump. The three plungers are of the same diameter and work to the same maximum pressure. The stroke is 2¾ inches and each plunger has a speed of 35 feet per minute at 150 strokes per minute, which is the rated speed. When driven at this speed the pump has a total capacity of 0.41 gallon to 4.20 gallons per minute, depending upon the diameter of the plungers. The suction and discharge valves are located in the pump cylinder.

The frame of the pump is cast in one piece of semi-steel; the crankshaft is machined from a solid bar of steel; the cross-heads are of cold-rolled steel; the connecting-rods are made of malleable iron with bronze bearings; and the pump plungers are of naval bronze on all diameters, except on the 5/16-inch and ⅜-inch sizes where steel is used to withstand the high pressure. The pump cylinders are cast *en bloc*. With the 5/16-inch and ⅜-inch plungers the cylinder is made of forged steel. For the pumps having plunger diameters larger than ⅜ inch, a special bronze is used for the cylinders. The pump has a height over all of 35 inches, and occupies a floor space of 16 by 18 inches. The weight of the pump without motor base or belt shifter is only 500 pounds.



Hydraulic Vertical Single-acting Triplex Pump

IMPROVEMENT ON BRYANT CHUCKING GRINDER

On the chucking grinder made by the Bryant Chucking Grinder Co., Springfield, Vt., which was described in its original form in the November, 1909, number of MACHINERY, the starting and stopping of the work-spindle was accomplished by an idler on the overhead countershaft, that was thrown against the belt or released from it in order to make or break the driving contact of the belt on the pulley. To provide a more rapid and convenient means of stopping and starting the machine—for gaging the work while grinding, etc.—a friction clutch has been provided in the driving pulley and this clutch is automatically operated by the withdrawal of the grinding wheel carriage from the working position. Aside from the greater convenience in starting or stopping, this improvement in no way affects the principle on which the machine works.

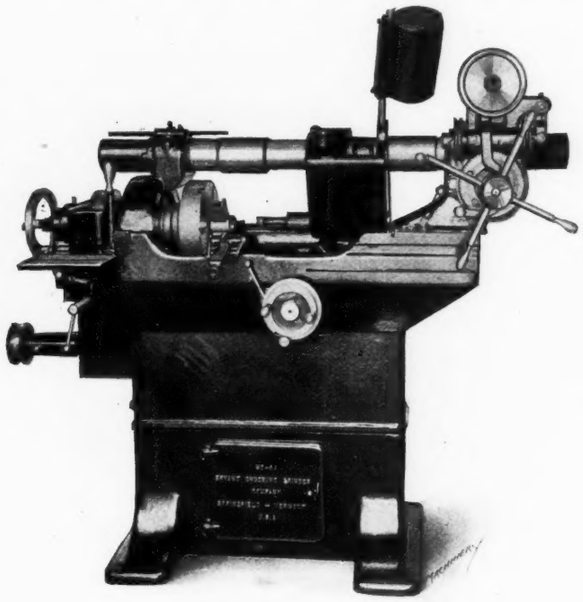


Fig. 1. Improved Bryant Chucking Grinder

A bracket has been placed at the center of the top casting of the machine, which carries a cam surface that is engaged by a roller supported from the under side of the grinding wheel spindle housing. When the grinding wheel is withdrawn beyond the operating position, this roller engages the cam surface, causing the wheel-spindle and its mounting to swing away and give the operator room for gaging the work. The bracket has a section at its right-hand end parallel to the grinding line, that acts as a support for the grinding wheel slide while gaging is being done. The swinging back of the grinding wheel head causes a movement of a shifter rod at the rear of the machine to take place. This rod extends over to the clutch in the driving pulley and throws it out. Conversely, the advance of the grinding wheel head causes this rod to swing back and the clutch is thus thrown in. Consequently, the single operation of withdrawing the grinding wheel causes it to swing out of the way for gaging and also causes the work-spindle to stop, while the cycle takes place in the reverse order in starting. This greatly simplifies the operation of the machine and adds materially to its efficiency.

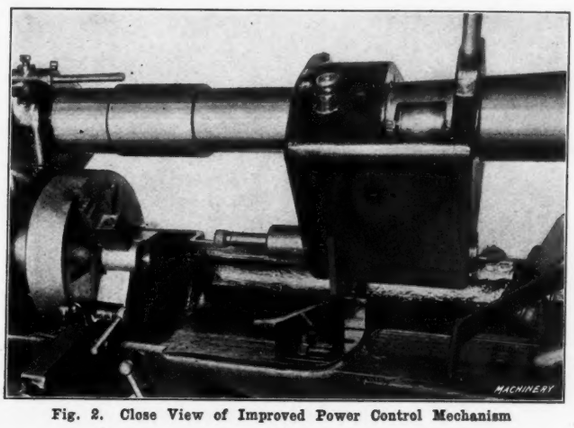
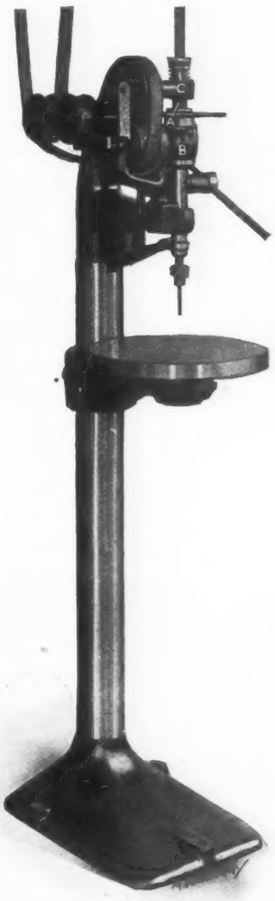


Fig. 2. Close View of Improved Power Control Mechanism

RICKERT-SHAFER VERTICAL TAPPING MACHINE

In the September, 1914, number of MACHINERY the horizontal tapping machine manufactured by the Rickert-Shafer Co., Erie, Pa. was illustrated and described. In this machine there is an aluminum disk mounted on the spindle which can be engaged with either of two friction disks which rotate in opposite directions. In this way provision is made for the reversal of the spindle for backing out the tap after it has reached the required depth. The disk on the spindle is engaged with the driving friction by feeding the work up to the tap, thus causing the disk on the spindle to be pushed into contact with the friction. After the desired depth has been reached, the work is drawn back, thus pulling the spindle in the opposite direction and engaging the disk with the reverse friction to provide for backing out the tap.



Rickert-Shafer Vertical Tapping Machine

The vertical machine which is illustrated herewith has recently been placed on the market by the Rickert-Shafer Co., and combines the same form of friction drive used on the horizontal machine with a hand-operated vertical movement of the spindle. The hand-operated sliding motion for the spindle was adopted owing to the fact that it was found impractical to raise and lower the table when handling certain classes of work. The spindle on which the friction disk is mounted is shown at *A*, and this spindle also carries the operating bracket *B* on which a pinion is mounted that raises and lowers the tapping spindle. The friction disk spindle also carries an adjustable compensating spring *C* that is used to hold the friction disk in the neutral position when the machine is not in use. The tapping spindle is connected to a counterweight which is sufficiently heavy to withdraw the tap from the work and lift the spindle to its highest position, leaving the operator's left hand free to reach for the next piece of work. On this machine the friction disk is brought into contact with the driving friction by a slight downward pressure on the hand lever, thus eliminating a large amount of strain on the tap and providing a powerful though sensitive tool. It will be seen that the machine is driven by a single belt which runs around the pulleys that drive the forward and reverse frictions in the manner shown. The two pulleys rotate in the same direction and the reversal of the tap is due to the fact that the friction disk comes into contact with the opposite sides of the forward and reverse frictions.

RIVETT INTERNAL GRINDING MACHINE

This No. 8 plain internal grinder is not intended for handling work where power feed is required, for which purpose the No. 3 internal grinder of this company's manufacture is well suited. Its particular field is work where the actual time of grinding is so short that one operator cannot attend to more than one machine. In designing this grinding machine particular attention has been paid to the provision of convenient means for controlling all parts of the mechanism.

To meet the requirements of internal grinding where the duration of each operation is so short that it is not practical to use power feed and have each operator in charge of more than one machine, the Rivett Lathe & Grinder Co., Brighton, Boston, Mass., has developed the No. 8 plain internal grinder which is illustrated and described herewith. In general, it may be stated that this machine is intended for roughing operations or for work where the highest degree of accuracy and the highest quality of finish are not essential.

Referring to Fig. 1 it will be seen that the work-head is mounted on a carriage which is traversed by means of a pilot wheel. The shaft on which this pilot is mounted carries a pinion which meshes with a rack on the under side of the carriage. This rack and pinion are of the herringbone type and provide a smooth uniform feed motion. The work-spindle is of the standard construction used on other Rivett grinding machines and runs in hardened and ground bushings. The work may be rotated at either 300 or 590 revolutions per minute, and the work-head may be swiveled up to 25 degrees either way from the center to provide for grinding tapered work. The head is positively located in the central position by a tapered pin. The spindle is ground internally to take draw-in collets, and the nose of the spindle is threaded and hardened so that any of the regular methods of holding work may be employed.

Fig. 1. Rivett No. 8 Internal Grinding Machine

An improved form of water guard has been applied on this machine, which consists of a casting in which either of three sheet metal shields of different widths may be easily inserted or removed. These shields hold themselves securely in place without requiring the use of screws or any other form of fastening. The arrangement is simple and effective. The regular type of pump is located at the back of the grinder and delivers the water through the spindle, the connection between the pump and spindle being easily detached if necessary. The water may also be directed against the work from the outside. The swing of the work-head is 7 inches and

Fig. 2. Opposite Side of Rivett Grinding Machine shown in Fig. 1

the carriage has a travel of 4¼ inches. A spring bumper is provided which absorbs the shock at the end of the stroke. The entire grinding machine table is surrounded by a deep guard which prevents the water from running over the sides of the machine.

The wheel-spindle is mounted in ball bearings and the entire spindle may be quickly removed from the machine by simply loosening two wing nuts. The spindle is driven from the countershaft on the machine by means of an endless cloth belt, and the desired belt tension is maintained by means of a spring acting in connection with the countershaft. The countershaft which drives the grinding wheel spindle also runs in ball bearings. Two movements are provided for the wheel-head, the first of which is the regular cross-feed con-

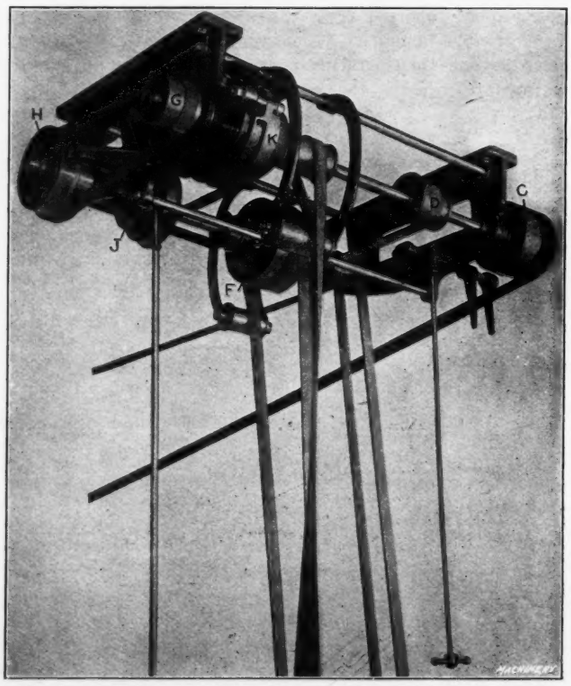


Fig. 3. Special Countershaft used in connection with Rivett Grinder

trolled by the handwheel shown in Fig. 1, which provides a maximum cross movement of 1 inch forward from the central position and 2 inches back from the central position. The feed-screw is of large diameter and runs in an exceptionally long nut. The micrometer collar on the feed-screw is graduated to 0.001 inch and the spaces on the collar are so wide that it is an easy matter to accurately estimate to 0.0001 inch.

The second movement of the wheel-head referred to is provided by an auxiliary slide mounted on the wheel-head carriage. This slide is normally locked in the central position, but when space is required for chucking and removing the finished work, or for gaging work during a grinding operation, the wheel may be moved back 4 inches by means of this auxiliary slide. For this purpose the pin which locks the auxiliary slide to the carriage is lifted out of engagement by means of the small handle *A* which turns a pinion that meshes with rack teeth cut in the locking pin. After the pin has been lifted out of engagement, the vertical handle *B* is used to push the slide back. A spring bumper is provided to absorb the shock when the slide reaches the end of its travel.

Three grinding wheel speeds of 11,200, 15,200 and 21,400 revolutions per minute are available; but in spite of these high speeds there is never any trouble due to heating of the spindle bearings. These three speeds, in connection with the two available work speeds, afford plenty of latitude for handling all sizes of work for which the machine is adapted. The floor space occupied by the machine is 2½ by 3 feet and the weight approximately 1000 pounds.

The Countershaft

A special countershaft has been developed for use in connection with the Rivett No. 8 internal grinding machine. In this countershaft there are only two shafts. Referring to Fig. 3, it will be seen that power is brought to the countershaft by the belt running on the tight and loose pulleys *C*. Keyed to the same shaft there is a cone pulley *D* from which power is transmitted to a cone pulley which is mounted on ball bearings and runs freely on the second shaft. Secured to this pulley there is a pulley *F*, over which a belt runs down to the countershaft on the machine from which the grinding wheel spindle is driven, the tension of the belt being maintained by an idler pulley as shown in the illustration. At the opposite end of the shaft from the tight and loose pulleys *C* there is a pulley *G*, over which a belt runs to the tight and loose pulleys *H* which drive the second shaft. From the cone pulley *J* on this shaft, a belt runs back to the first shaft and drives a cone pulley *K* secured to the left-hand end of the drum over which the belt runs which drives the work-head. In addition to driving the drum, the second shaft carries another pulley from which the drive is carried down to the pump on the grinder.

Secured to the cone pulley *K* there is a brake drum which is engaged by a band brake that provides for quickly stopping the rotation of the work-head. The treadle at the front of the grinding machine operates this band brake. When the treadle is pushed down, it throws a bell-crank which operates a square rod on the countershaft, this rod being given a sidewise motion which operates the belt shifter to throw the belt from the tight to the loose pulley *H* or *vice versa*, thus causing the work-head and pump to be stopped or started. At the same time the band brake is automatically engaged or disengaged by a cam mechanism, the band brake being disengaged when the belt is thrown onto the tight pulley or engaged to quickly stop the rotation when the belt is thrown onto the loose pulley to stop the machine. The foot treadle is mounted on ball bearings so that it operates very easily. The countershaft as a whole is started or stopped by the hand lever above the machine which throws the driving belt from the loose to the tight pulley, or *vice versa*.

STANDARD DROP HAMMER SAFEGUARD

The safeguard for drop hammers, which is illustrated and described herewith, has been developed by the Standard Machinery Co., Auburn, R. I., for use on any type of plain, automatic or board drop hammer where the operator uses his hands to place the work on the die. The guard is not intended for hammers handling hot work, as such parts are handled with tongs, and as a result there is no danger of injury to the operator's hands. Reference to the illustration will make the principle upon which this device operates quite clear without requiring more than a brief description. It will be seen that there is a "fan" or plate which swings over the face of the die. When the hammer is at the top of its stroke, this guard is back of the die so that the latter is exposed to enable the operator to put the work in place. When the hammer descends, the roller shown in the illustration engages the inclined arm on which the plate is supported, causing it to swing across the face of the die.

Standard Safeguard for Use on All Types of Drop Hammers

Should the operator trip the hammer and neglect to move his hand, the plate will push it out of the danger zone. The face of the plate is covered with leather so that it cannot bruise the workman's hand. An important feature is that the guard is bound to operate no matter whether the hammer is dropped in the usual way or if its descent is caused by some abnormal condition, such as the breaking of a belt, etc. When the hammer rises, the guard is returned to the position shown in the illustration by means of the two coiled springs. To adapt the guard for use on hammers of different widths, the bolts in the side brackets fit into slots so that the brackets may be adjusted to fit the hammer on which the guard is to be used. Similarly, the bolts which connect the swinging arm to the side brackets fit into slots so that the vertical position of the guard plate may be regulated for dies of various heights.

NEW MACHINERY AND TOOLS NOTES

Hoist: Wright Mfg. Co., Lisbon, Ohio. A shop hoist which has a capacity for loads ranging from 300 to 600 pounds. A new form of hand chain is provided for operating the hoist, which makes jerking and catching of the chain impossible.

Filing Machine: Thurston Mfg. Co., Providence, R. I. A machine particularly adapted for accurate filing operations on die work. The adjustment of the table provides for obtaining any desired clearance angle from 1 to 10 degrees, or for filing the hole in a die square.

Staybolt Machine: Ferracute Machine Co., Bridgeton, N. J. A coining press equipped to shear a staybolt blank from a bar and form the head on the preceding blank. These two operations are performed simultaneously and the finished bolt is ejected from the machine.

Shaft Centering Machine: Detrick & Harvey Machine Co., Baltimore, Md. A machine adapted for centering shafting, solid gun forgings, etc. This consists of two headstocks and two vises for holding the work, which are mounted on a common bed. The headstocks are motor driven.

Keyseating Attachment: Sunderland Machinery & Supply Co., Omaha, Neb. An attachment which provides for performing keyseating operations on an engine lathe. Various other milling and slotting operations can also be performed, and the attachment can be used on any lathe ranging from 13 to 26 inches swing.

Double Disk Grinder: Guy G. Townsend, Winchendon, Mass. A double disk grinder in which the shaft and heads are made from a solid forging. A truing attachment is bolted to the swing slide, where it is readily available. The machine is built in three sizes having wheels 18, 24 and 30 inches in diameter, respectively.

Car Wheel Boring Machine: Putnam Machine Co., Fitchburg, Mass. This is the machine formerly built by this company with several important improvements incorporated in its design. Chief among the changes is the substitution of single pulley and geared drive in place of the cone pulley drive formerly employed.

Ball Bearing: Auburn Ball Bearing Co., 33 Elizabeth St., Rochester, N. Y. Special ball thrust bearings built for the United States Government for use at the Jupiter Inlet Lighthouse on the Florida coast. These bearings are used on the revolving "flash panels" which give the light its distinctive periods of illumination and darkness.

Grinding Machine: Norton Grinding Co., Worcester, Mass. A plain grinding machine which has a swing of 10 inches, and a capacity for handling work up to 50 inches in length carried on centers. Other sizes of this machine are made to handle work 36 and 24 inches in length, respectively, the swing being the same, i.e., 10 inches.

18-inch Lathes: Monarch Machine Co., Sidney, Ohio. Two 18-inch quick-change gear lathes which are of similar design except that one machine is fitted with a turret, while the other machine is not equipped in this way but is provided with cabinet legs. The turret machine is particularly adapted for machining projectiles and is made with a six-foot bed.

Piston Ring Lathe: Reed-Prentice Co., Worcester, Mass. In the August, 1914, number of MACHINERY an automatic lathe built by the Reed-Prentice Co., Worcester, Mass., for the Ford Motor Co., was illustrated and described. Since that time the design of the machine has been slightly modified to adapt it for turning automobile engine piston rings.

Friction Saw: Joseph T. Ryerson & Son, Chicago, Ill. A high-speed friction saw designed for cutting rails, I-beams, angle irons and other steel shapes. The saw is known as a No. 3 size. The mechanism is carried on a heavy cast-iron base of box section. The wheel-head operates horizontally on vertical rollers with horizontal rollers to prevent sidewise motion.

Hydraulic Pump: L. Henderer's Sons, Wilmington, Del. A combined quick-acting and high-pressure hydraulic pump which is of the double piston type and operated by hand. The provision of two pistons enables continuous discharge to be secured. The principal feature of the pump is the variation of pressure that can be obtained, the range being from 1000 to 6000 pounds per square inch.

Wiring and Horning Press: Fred J. Swaine Mfg. Co., St. Louis, Mo. The noteworthy feature of this machine is the exceptional distance between the slide and table, which makes the press suitable for work which is too high to be handled on a machine of ordinary dimensions. The table is hinged to the column and may be swung out of the way to adapt the press for horning operations.

Grinding Machine: St. Louis Machine Tool Co., St. Louis, Mo. A self-contained countershaft grinding machine. Making the countershaft an integral part of the machine does away with the necessity of attaching it to the ceiling and lining it up properly. It is claimed that all belt strain comes against the body of the machine and that an unusually smooth running transmission is secured.

Bending Machine: Riehle Bros. Testing Machine Co., Philadelphia, Pa. This machine has a capacity for bending bars up to 2½ inches square, and may be readily adjusted for handling different sizes of bars, center pins of various diameters being used for this purpose. It is adapted for either individual motor drive or belt drive. This machine is intended for testing material by bending it cold.

Clutch: O. K. Clutch & Machinery Co., Columbia, Pa. A combination friction and positive clutch which is especially adapted for use on heavy-duty machinery. The load is picked up by the friction clutch, after which the positive clutch may be engaged for driving. However, the frictions are strong enough to carry a heavy load. The clutch is easily engaged or disengaged by a single operating lever.

Shaper Feed Mechanism: Queen City Machine Tool Co., Cincinnati, Ohio. An improved feed mechanism which has been applied to the 20- and 24-inch machines of this company's manufacture. An important feature of this device is that it is designed along lines which make it impossible for the operator to be injured by the gearing or for carelessness on the part of the workmen to result in damage to the machine.

Universal Milling Machine: Rockford Milling Machine Co., Rockford, Ill. An all-geared universal miller in which all shafts with the exception of the main spindle run in Hyatt roller bearings. The starting lever may be placed on either side of the machine; and a feed reverse lever which controls all feed motions is located at each side of the knee. The feed trip lever which disengages all feeds is at the front of the knee.

Suspended Grinding Machine: Stow Mfg. Co., Binghamton, N. Y. A direct-connected drilling, buffing and grinding machine that is suspended from the ceiling. The driving motor is provided with a cord and connection for taking power from a standard lamp socket. The motor is held at one end of a rod which is counterbalanced by a weight, the position of which is adjustable. The grinding wheel or buff is driven by a flexible shaft.

Hardening Furnace: Chicago Flexible Shaft Co., 149 W. La Salle St., Chicago, Ill. A furnace in which three units are mounted on a single base. At the left-hand end there is a crucible for a barium chloride bath. The center section consists of an oven with a molded fireclay lining. At the right-hand end there is a furnace of the direct heat-giving type which provides a sufficiently intense temperature for the heat-treatment of high-speed steel.

Geared Table Feed: W. B. Knight Machinery Co., St. Louis, Mo. This company has recently applied a geared table feed to the vertical milling and drilling machine which it manufactures. This consists of a geared speed-box mounted near the top of the column from which a telescoping universal jointed shaft transmits the motion to the cross shaft in the saddle. Only the transverse motion is given to the table, the cross-feeding being done by hand.

Safety Hood for Grinding Wheels: Pittsburg Emery Wheel Co., Rochester, Pa. It is claimed that this hood meets all the requirements of the Pennsylvania Department of Labor and Industry in regard to safety regulations. The hoods are rigidly constructed of 8-inch channel and sheet steel. Cast-iron caps are mounted on the hoods to protect the ends of the spindle and nuts. Ample adjustment is provided, and the hoods are so constructed that there is plenty of room beneath the wheel where particles of metal and abrasive may collect.

Adjustable Tool-holder: Krieger Tool & Mfg. Co., Grand Rapids, Wis. A combination adjustable lathe, drill press, milling machine, boring and grinding tool-holder which is used in combination with the Krieger adjustable lathe boring tool-holder. It consists of a taper shank which carries an eccentric wrist-pin, the shank fitting into the machine spindle. The eccentric wrist-pin allows the head to swing so that holes ranging from ½ to 6 inches in diameter may be bored. This holder is particularly adapted for work which cannot be swung in a lathe, such as frame castings, crank rods, etc.

Universal Joint: Plank Flexible Shaft Machine Co., Grand Rapids, Mich. In the April, 1914, number of MACHINERY the three-piece universal joint of this company's manufacture was illustrated and described. Since that time the design has been improved in certain details, among which the following may be mentioned: There is now only one position in which the joint can be taken apart instead of two positions as was formerly the case. The size of the center-block has been increased to give greater durability. A ball center has been adopted in place of the sharp fillet formerly employed. These changes give increased strength and durability, thus making the joint better adapted for severe classes of work.

* * *

The Shipping, Engineering and Machinery Exhibition which was scheduled to be held at Olympia, London, England, September 25 to October 17, 1914, was postponed to August and September, 1915, owing to the outbreak of the European war. The promoters of the exhibition point out that it will afford the manufacturers of the United States an exceptional opportunity of showing what the resources of this country are, not only for the British buyer but for the buyers from other parts of Europe. The capture of German and Austrian trade in general engineering machine tools, shipping appliances, etc., is engaging special attention in England and the United States, and the exhibition offers the opportunity for the American manufacturers to show their specialties under favorable conditions. The committee having the exhibition in charge is prepared to set aside for collective American exhibits about 20,000 square feet of floor space, all near the center of the hall and practically forming one block.

* * *

CORRECTION

In the advertisement of the American Emery Wheel Works, Providence, R. I., appearing on page 95 of the February number of MACHINERY, the wheel-cost per box should have been given as $0.002, instead of $0.1002. The purpose was to indicate that the wheel-cost per box was remarkably low, which would not have been the case if the cost had actually been $0.1002.

ELECTRO-MAGNET FOR REMOVING PARTICLES OF IRON FROM THE FLESH

The removal of pieces of shrapnel, steel-jacketed bullets, etc., by the use of powerful electro-magnets in hospitals abroad has been highly praised by many newspapers as a most valuable application of science to surgery. It is interesting to note that the Westinghouse Electric & Mfg. Co. has installed in the relief department of its East Pittsburg Works a magnet for removing metal embedded in the flesh, which is one of the most powerful in the world. This magnet is mounted on a box containing the resistor which is used to regulate the amount of current flowing through the coils. It requires 4000 watts for its operation, or enough power to supply 100 32-candlepower Mazda lamps. It is designed for operation on 70 volts, and as the circuit from which it draws current is used for testing purposes and ranges from 70 to 120 volts, a resistor is necessary.

It is not an infrequent occurrence for steel and iron workers to get bits of metal in their eyes or hands. Previous to the installation of a magnet the only means of removal was by probing, a method which is as uncertain as it is painful. Since this machine has been in operation it is a very simple proceeding to extract such particles. The portion of the body in which the foreign particle is embedded is placed near the pole tip of the magnet, the switch closed, and the magnet does the rest. The pole is removable, a number of different shapes being supplied for various classes of work. It is very common for flying bits of metal to lodge in the eye; and should they strike with force enough to become embedded, their removal without the aid of a powerful magnet is apt to be difficult as well as painful. The protecting coating of the eye must be cut, and there is danger that instead of removing the particle, it may be pushed further into the eye. When the foreign body is once within the eyeball it is properly a case for the specialist.

Steel workers frequently have their hands punctured with minute pieces of metal, which become embedded under the calloused skin. If these bits are allowed to remain, the wound is likely to become infected. The use of a powerful magnet insures the removal of all traces of iron from such wounds in the hand, or any other part of the body. Some remarkably small pieces have been extracted in this way, one recently recovered being not a twelfth of the thickness of a delicate needle. Dr. C. A. Lauffer, medical director of the Westinghouse Electric & Mfg. Co., relates a number of instances in which the magnet has proved invaluable. Among these is the rather amusing case of a workman who attempted to drill one of his own teeth. The drill broke off about half an inch from the end and remained in the cavity, and it seemed as if the only way to remove it would be to pull the tooth. However, a special extension was made and fitted to the magnet pole. As soon as the extension was brought in contact with the drill and the current switched on, the drill was immediately drawn out.

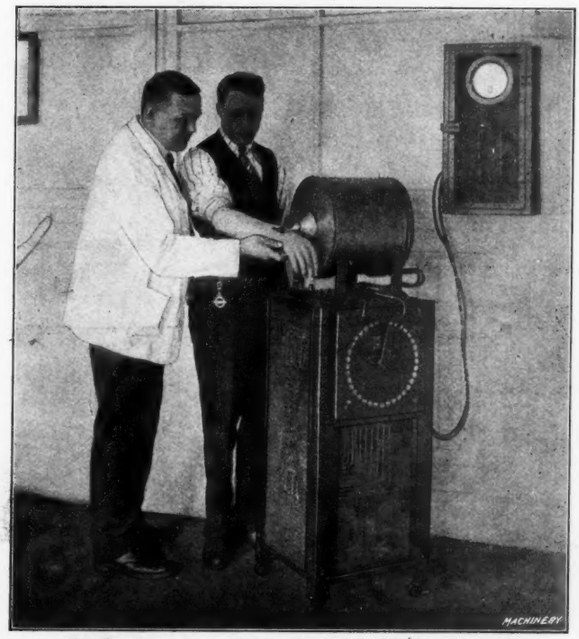


Fig. 1. Removing a Chip embedded in Workman's Wrist

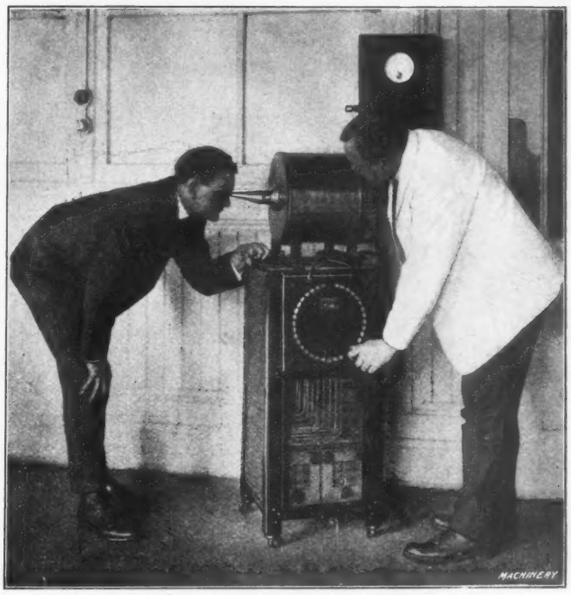


Fig. 2. The Electro-magnet is especially Useful in removing Particles of Iron from Eye

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THE A. S. M. E. BOILER CODE

One of the most extensive undertakings ever attempted by an engineering society was brought to a close in February when the council of the American Society of Mechanical Engineers received the report of the boiler code committee of that society. The report contains specifications for the construction of stationary steam boilers and rules for allowable working pressures. The work of its preparation was begun nearly four years ago and has since been continuously under way by the following committee: John A. Stevens, chairman, W. H. Boehm, Rolla C. Carpenter, Richard Hammond, Charles L. Huston, Edward F. Miller and E. D. Meier (deceased).

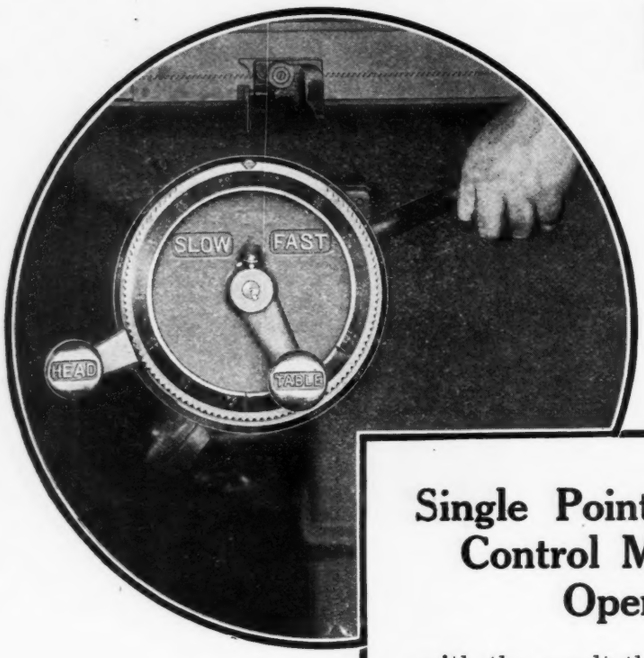
In the preparation of the preliminary draft of the work, frequent conferences were held with engineers, manufacturers and associations interested and a public hearing was finally arranged, which took place last September in the Engineering Societies Building in New York and was largely attended. It is noteworthy that as a result of these conferences and hearings, an agreement was reached upon uniform specifications for boiler steel and other material and for boiler tubes; and uniform rules for safety valves, fire-tube boilers, water-tube boilers and steam and hot water heating boilers.

At the conclusion of these hearings the code was entirely revised and brought up for discussion at the annual meeting in December where the interest in the matter was so great that five sessions were devoted to this subject. The many suggestions that were there offered were then digested, and to facilitate the work and bring to bear a still broader experience and consequent authoritative rendering of the report, an advisory committee of eighteen prominent engineers was appointed to sit with the regular boiler code committee. The final work of revision began on December 15 and continued without interruption until presented to the council on February 13.

The report has the merit of being condensed, comprising only about 100 pages, and it is phrased with great care. It is expected that it will form a model for such states as introduce laws governing the construction of steam boilers, and materially assist in bringing about uniformity of construction along safe lines.

How It's Done

This simple and efficient controller mechanism gives full and instant control of the entire machine, independent of the wheel.



Single Point, One Hand Control Means Easy Operation

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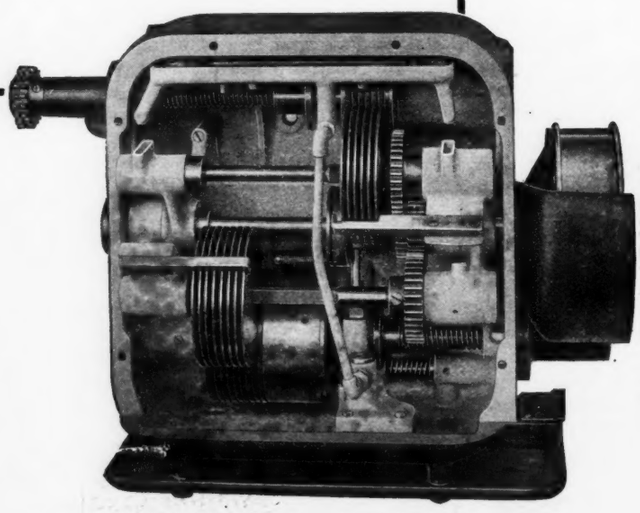

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ELECTRO-MAGNET FOR REMOVING PARTICLES OF IRON FROM THE FLESH

The removal of pieces of shrapnel, steel-jacketed bullets, etc., by the use of powerful electro-magnets in hospitals abroad has been highly praised by many newspapers as a most valuable application of science to surgery. It is interesting to note that the Westinghouse Electric & Mfg. Co. has installed in the relief department of its East Pittsburg Works a magnet for removing metal embedded in the flesh, which is one of the most powerful in the world. This magnet is mounted on a box containing the resistor which is used to regulate the amount of current flowing through the coils. It requires 4000 watts for its operation, or enough power to supply 100 32-candlepower Mazda lamps. It is designed for operation on 70 volts, and as the circuit from which it draws current is used for testing purposes and ranges from 70 to 120 volts, a resistor is necessary.

It is not an infrequent occurrence for steel and iron workers to get bits of metal in their eyes or hands. Previous to the installation of a magnet the only means of removal was by probing, a method which is as uncertain as it is painful. Since this machine has been in operation it is a very simple proceeding to extract such particles. The portion of the body in which the foreign particle is embedded is placed near the pole tip of the magnet, the switch closed, and the magnet does the rest. The pole is removable, a number of different shapes being supplied for various classes of work. It is very common for flying bits of metal to lodge in the eye; and should they strike with force enough to become embedded, their removal without the aid of a powerful magnet is apt to be difficult as well as painful. The protecting coating of the eye must be cut, and there is danger that instead of removing the particle, it may be pushed further into the eye. When the foreign body is once within the eyeball it is properly a case for the specialist.

Steel workers frequently have their hands punctured with minute pieces of metal, which become embedded under the calloused skin. If these bits are allowed to remain, the wound is likely to become infected. The use of a powerful magnet insures the removal of all traces of iron from such wounds in the hand, or any other part of the body. Some remarkably small pieces have been extracted in this way, one recently recovered being not a twelfth of the thickness of a delicate needle. Dr. C. A. Lauffer, medical director of the Westinghouse Electric & Mfg. Co., relates a number of instances in which the magnet has proved invaluable. Among these is the rather amusing case of a workman who attempted to drill one of his own teeth. The drill broke off about half

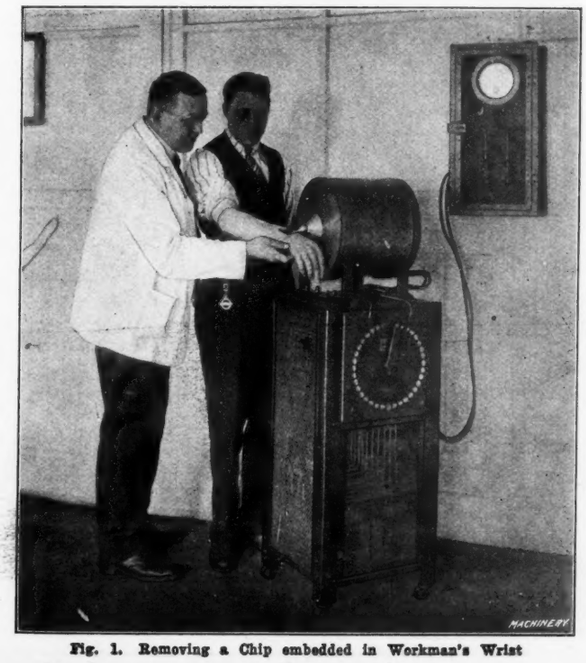


Fig. 1. Removing a Chip embedded in Workman's Wrist

Fig. 2. The Electro-magnet is especially Useful in removing Particles of Iron from Eye

an inch from the end and remained in the cavity, and it seemed as if the only way to remove it would be to pull the tooth. However, a special extension was made and fitted to the magnet pole. As soon as the extension was brought in contact with the drill and the current switched on, the drill was immediately drawn out.

* * *

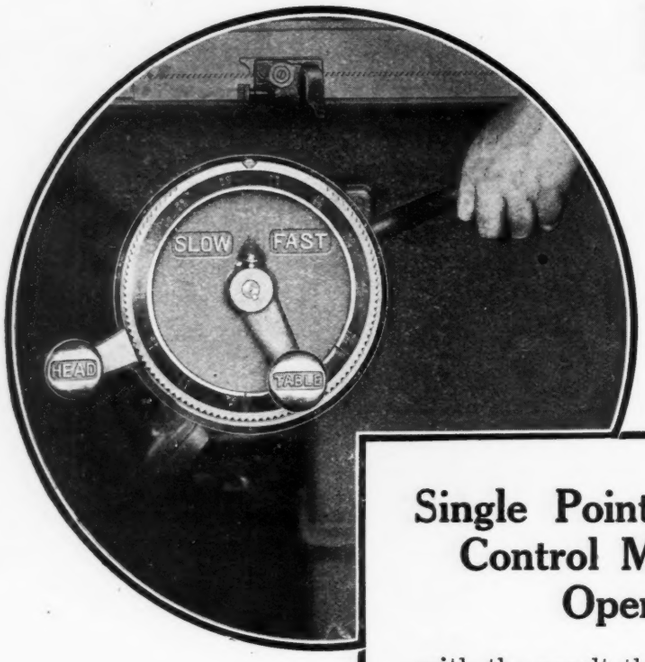
THE A. S. M. E. BOILER CODE

One of the most extensive undertakings ever attempted by an engineering society was brought to a close in February when the council of the American Society of Mechanical Engineers received the report of the boiler code committee of that society. The report contains specifications for the construction of stationary steam boilers and rules for allowable working pressures. The work of its preparation was begun nearly four years ago and has since been continuously under way by the following committee: John A. Stevens, chairman, W. H. Boehm, Rolla C. Carpenter, Richard Hammond, Charles L. Huston, Edward F. Miller and E. D. Meier (deceased).

In the preparation of the preliminary draft of the work, frequent conferences were held with engineers, manufacturers and associations interested and a public hearing was finally arranged, which took place last September in the Engineering Societies Building in New York and was largely attended. It is noteworthy that as a result of these conferences and hearings, an agreement was reached upon uniform specifications for boiler steel and other material and for boiler tubes; and uniform rules for safety valves, fire-tube boilers, water-tube boilers and steam and hot water heating boilers.

At the conclusion of these hearings the code was entirely revised and brought up for discussion at the annual meeting in December where the interest in the matter was so great that five sessions were devoted to this subject. The many suggestions that were there offered were then digested, and to facilitate the work and bring to bear a still broader experience and consequent authoritative rendering of the report, an advisory committee of eighteen prominent engineers was appointed to sit with the regular boiler code committee. The final work of revision began on December 15 and continued without interruption until presented to the council on February 13.

The report has the merit of being condensed, comprising only about 100 pages, and it is phrased with great care. It is expected that it will form a model for such states as introduce laws governing the construction of steam boilers, and materially assist in bringing about uniformity of construction along safe lines.



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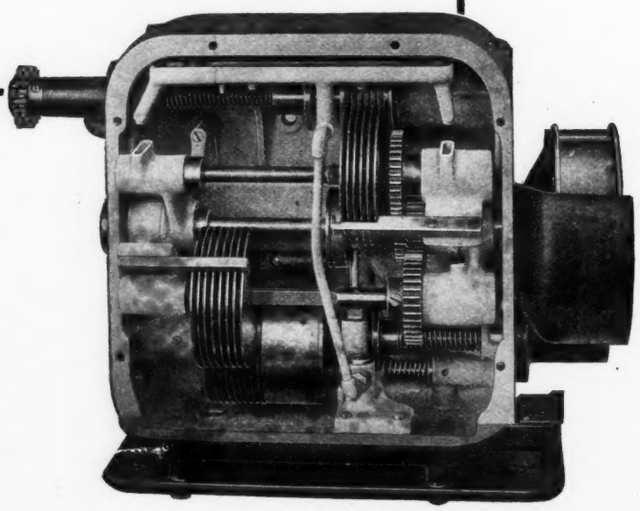

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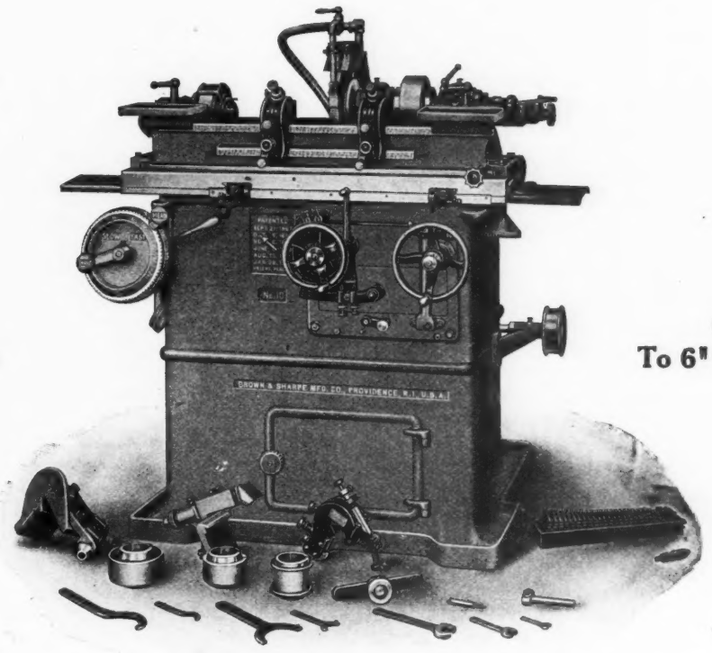

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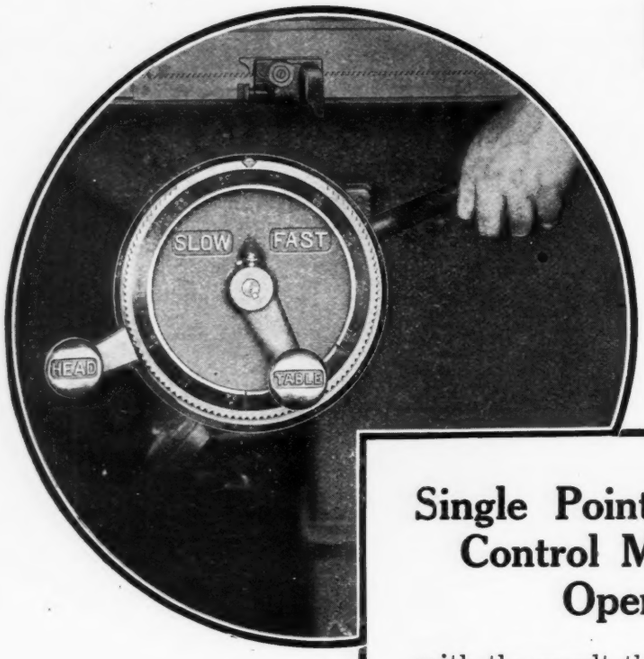

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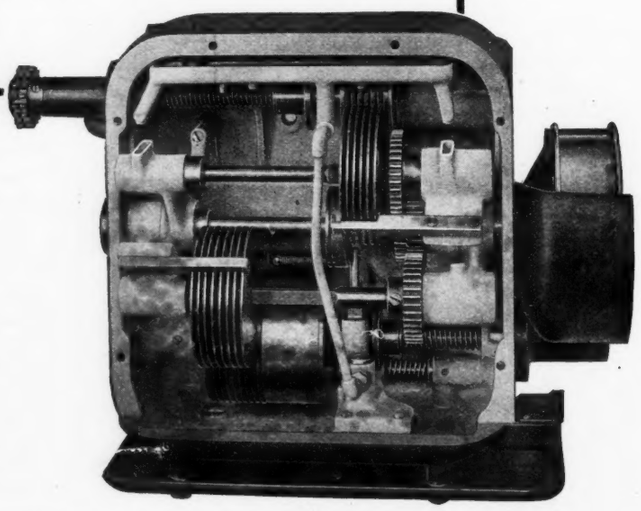

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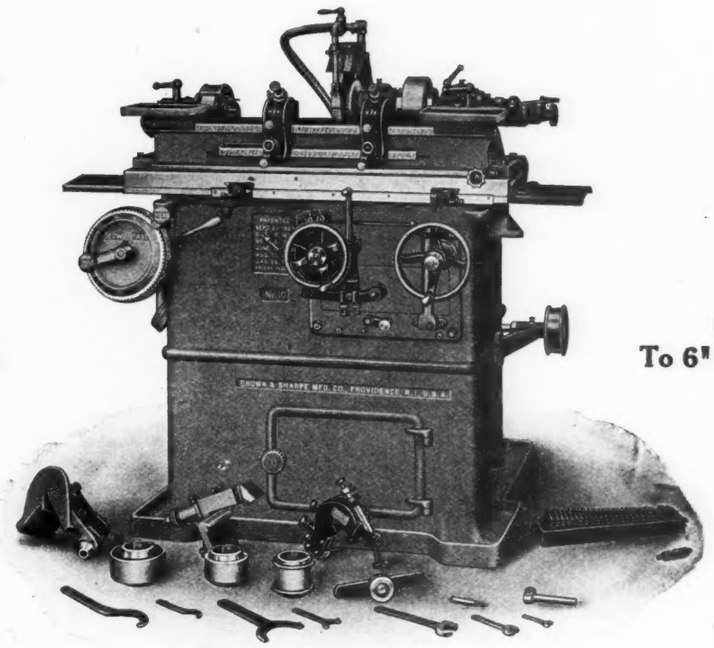

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* * *

Representative E. B. Follette has introduced a bill in the Michigan legislature to limit the prices charged for repairs of automobiles and farm implements. He made the statement that these concerns charge a profit of from 500 to 1000 per cent, and that the customer is helpless once having bought and paid for a machine. The bill provides that the manufacturer of machinery shall file with the secretary of state a schedule of prices on each type of machine sold and the costs of the component parts of the machine sold. The secretary of state will be empowered to refuse to accept this schedule if the total cost of the various parts exceeds by more than 25 per cent the cost of the assembled machine. If the manufacturer should insist on selling goods without registering such a schedule, he will be liable to a fine of not more than $1000, or imprisonment for not more than six months, or both.

* * *

Not less than fourteen eight-cylinder cars were shown at the Chicago Automobile Show and several other manufacturers have announced their intention of entering this field. There is no doubt in the minds of many automobile engineers as to whether this eight-cylinder fad—as it is termed by many—will last. Although no definite announcements have been made as yet, it is known that several makers contemplate bringing out a twelve-cylinder model, it having been stated by one company that if the public demanded a twelve-cylinder car, this company was prepared to furnish it. At the present time there is but one twelve-cylinder car made, this being a racing model of the "Sunbeam," a British make, which took part in the Indianapolis races last year.

* * *

The patent suit brought against the B. F. Sturtevant Co. of Boston by the Sirocco Engineering Co., which has been in the courts for the past six years, has just been decided by the United States Circuit Court of Appeals for the Second Circuit in favor of the Sturtevant Co. It was claimed that the Sturtevant multivane fan infringed the Sirocco Co.'s patents, and in the lower court this claim was sustained. The Court of Appeals, however, reversed the former decision and held that there was no infringement. The Court of Appeals further decided that the Sirocco patents in suit were void in view of the development of the fan building art prior to the alleged inventions upon which these patents were based.

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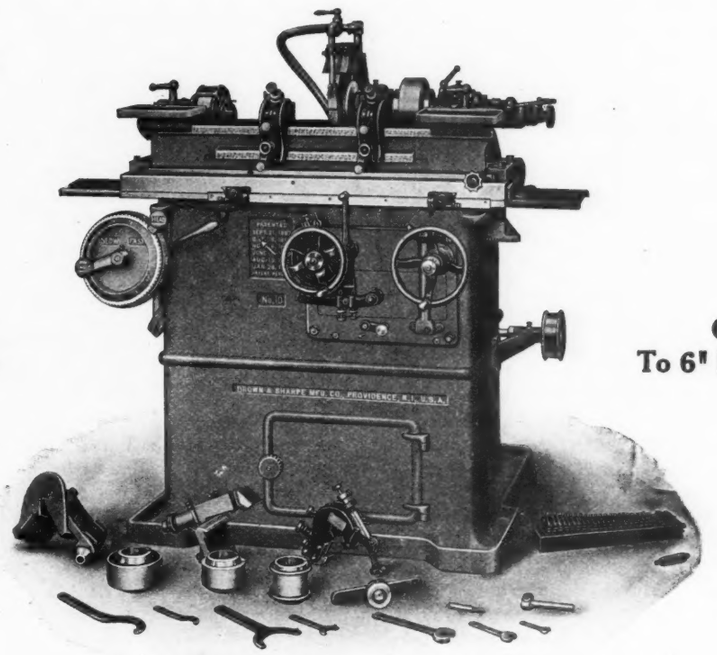

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Those qualified for participation in the profits are of three classes: (1) married men living with and taking good care of their families; (2) single men over twenty-two years of age who have proved to be of thrifty habits; (3) young men under twenty-two years of age and women who are the sole support of some next of kin. In order to be entitled to profit sharing, six months' employment with the company is required.

* * *

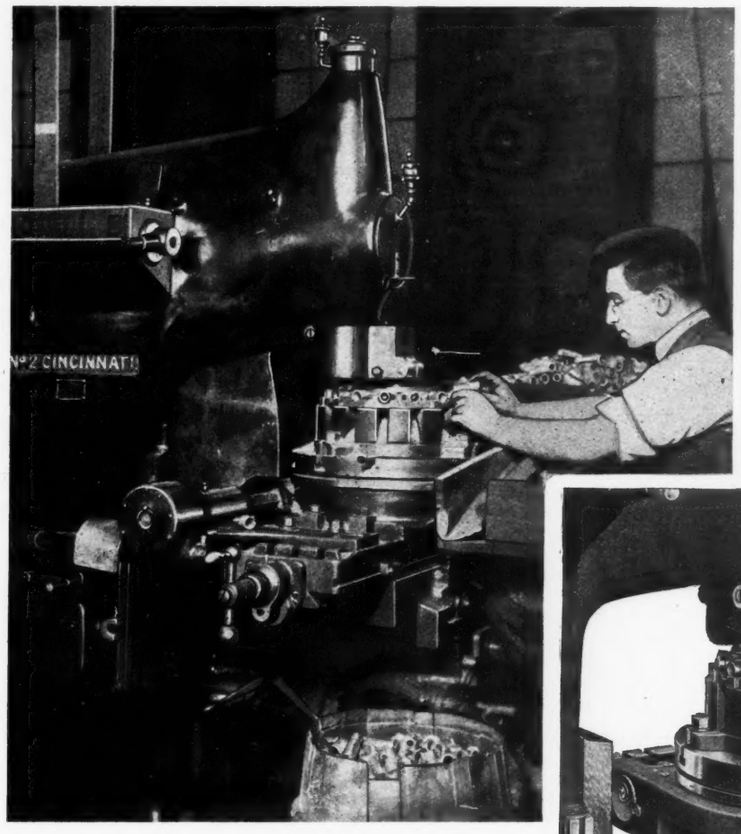
Representative E. B. Follette has introduced a bill in the Michigan legislature to limit the prices charged for repairs of automobiles and farm implements. He made the statement that these concerns charge a profit of from 500 to 1000 per cent, and that the customer is helpless once having bought and paid for a machine. The bill provides that the manufacturer of machinery shall file with the secretary of state a schedule of prices on each type of machine sold and the costs of the component parts of the machine sold. The secretary of state will be empowered to refuse to accept this schedule if the total cost of the various parts exceeds by more than 25 per cent the cost of the assembled machine. If the manufacturer should insist on selling goods without registering such a schedule, he will be liable to a fine of not more than $1000, or imprisonment for not more than six months, or both.

* * *

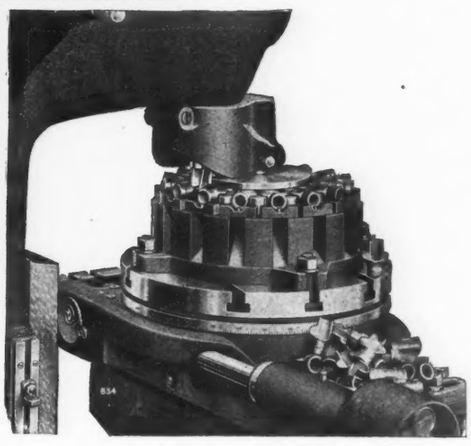
Not less than fourteen eight-cylinder cars were shown at the Chicago Automobile Show and several other manufacturers have announced their intention of entering this field. There is no doubt in the minds of many automobile engineers as to whether this eight-cylinder fad—as it is termed by many—will last. Although no definite announcements have been made as yet, it is known that several makers contemplate bringing out a twelve-cylinder model, it having been stated by one company that if the public demanded a twelve-cylinder car, this company was prepared to furnish it. At the present time there is but one twelve-cylinder car made, this being a racing model of the "Sunbeam," a British make, which took part in the Indianapolis races last year.

* * *

The patent suit brought against the B. F. Sturtevant Co. of Boston by the Sirocco Engineering Co., which has been in the courts for the past six years, has just been decided by the United States Circuit Court of Appeals for the Second Circuit in favor of the Sturtevant Co. It was claimed that the Sturtevant multivane fan infringed the Sirocco Co.'s patents, and in the lower court this claim was sustained. The Court of Appeals, however, reversed the former decision and held that there was no infringement. The Court of Appeals further decided that the Sirocco patents in suit were void in view of the development of the fan building art prior to the alleged inventions upon which these patents were based.



Cincinnati Cost Cutting



Output 1000 per Hour

These pieces are water meter parts. The milled sections are 1⅜" long by 1⅞" wide over all. Enough stock is removed to clean up each surface and give a flat bearing.

The Metric Metal Works finishes 1000 pieces per hour on the **Cincinnati No. 2 Vertical Cone** with this special circular milling attachment. The parts are automatically clamped and released. The operator's energy is confined to continuously inserting and removing pieces. He need not move from his seat for a single adjustment.

The Metric Metal Works is one of the many customers for whom we are saving time and money in their milling department. May we add you to the list? "Cold Chips" gives details.

THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI, OHIO, U. S. A.

THE SUBMARINE BATTLESHIP

The ultimate development of the submarine war vessel apparently means the doom of the modern battleship, but though the present type of submarine seems to be the invincible enemy of the battleship, its offensive powers are limited to the destruction of ships; it is powerless to act against land fortifications. Does this mean that the battleship of the future will be a vessel that can be submerged? Will it be equipped with heavy guns and turrets so it will be able to destroy land defenses as well as to hide beneath the waters and to creep up to an enemy unseen and unfelt until the deadly torpedo is launched? If the present type of battleship is costly, what will be the cost of the submarine type weighing 30,000 tons and capable of ranging 5000 miles from its base of supplies? Diesel engines, oil fuel and apparatus for extracting oxygen from sea water would mean almost unlimited submergence and freedom of movement. Turrets that withdraw snugly into the shell present no insuperable difficulties of construction. Given unrestricted resources, the possibilities of the war game are unlimited.

* * *

PERSONALS

L. H. Mesker is now connected with the sales department of Kearner & Trecker Co., Milwaukee, Wis., and will act as its representative in the state of Ohio.

James D. Wilson, former president and general manager of the Montague Iron Works Co., Montague, Mich., and Martin Hausler of South Chicago, Ill., have taken over the interests of the Montague Iron Works Co., and will continue the business along the same lines as in the past.

M. A. Sherritt, for several years associated with Manning, Maxwell & Moore, Inc., as manager of the Philadelphia branch, resigned his position to become vice-president and general manager of Sherritt & Stoer Co., Inc., Finance Bldg., Philadelphia, Pa., dealer in machine tools, railway and machine shop equipment.

David A. Wright, for several years connected with the Yale & Towne Mfg. Co., as district manager in the West, has gone into business for himself and opened an office as manufacturer's agent at 140 South Dearborn St., Chicago, Ill. Mr. Wright is specializing on labor saving and pneumatic machinery, cranes, hoists and trolley systems.

Guy E. Marion, secretary-treasurer of the Special Libraries Association, has severed his connection with Arthur D. Little, Inc., chemists, engineers and managers, 93 Broad St., Boston, Mass., where he has been located for the last five years in charge of their information department. Mr. Marion will devote himself to the organization and development of special libraries, or information departments, in business houses, industrial plants, etc. He occupies offices in the Tremont Bldg., Boston, with Warren H. Manning, landscape designer.

The machinery trade will be much interested in the announcement of Walter L. Clark's retirement from the Niles-Bement-Pond Co., followed a week later by the news of his connection with the important banking house of J. P. Morgan & Co. On February 1, Mr. Clark resigned as vice-president and sales manager of the big machinery house at 111 Broadway with the intention of giving up active work, but his retirement was quickly followed by an offer from J. P. Morgan & Co. of such a character that he decided to accept it. His connection with the banking house is in a consulting capacity in the firm's newly organized department for purchasing machinery and war materials for the British Government, the bankers acting as representatives of Great Britain in this country. They are fortunate in being able to secure the services of a man and executive so widely known and so thoroughly experienced in the mechanical field. Mr. Clark was for thirty-one years in the machine tool field—with the Niles Tool Works, Hamilton, Ohio, and with the Niles-Bement-Pond Co. as vice-president since the formation of the concern in 1901.

COMING EVENTS

April 12-15.—Annual convention of the National Metal Trades Association, New York City. Hotel Astor, headquarters. H. D. Sayre, secretary, Peoples Gas Bldg., Chicago, Ill.

April 24-May 1.—Second Efficiency Exposition at the Grand Central Palace, New York City. Organized by the Efficiency Society, Inc., 41 Park Row, New York City.

May 20-21.—Spring convention of the National Machine Tool Builders' Association at Atlantic City. Marlborough-Blenheim Hotel, headquarters. Charles E. Hildreth, general manager, Worcester, Mass.

June 8-11.—Third annual convention of the National Association of Corporation Schools at Worcester, Mass. H. W. Dunbar, general chairman of the convention committee, Norton Co., Worcester, Mass.

June 9-11.—Annual convention of the American Railway Master Mechanics Association, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 14-16.—Master Car Builders' annual convention, Atlantic City, N. J. J. W. Taylor, secretary, Karpen Bldg., Chicago, Ill.

June 19-26.—Annual convention of National Graphic Arts Exposition in the Coliseum, Chicago, Ill. Publicity manager, A. D. V. Storey, National Exposition Co., 200 Fifth Ave., New York City.

July 19-21.—Seventh annual convention of the American Railway Tool Foreman's Association, Chicago, Ill. Hotel Sherman, headquarters. Owen D. Kinsey, secretary and treasurer, 7223 Ridgeland Ave., Chicago, Ill.

August 17.—Annual meeting of the International Railroad Blacksmiths' Association, Philadelphia, Pa. A. L. Woodworth, secretary-treasurer, C. H. & D. Railway, Lima, Ohio.

September 9-11.—Swedish engineering convention in the United States; meeting in Chicago. Secretary, Eastern organization committee, E. Oberg, 183 68th St., Brooklyn, N. Y.; secretary Western organization committee, C. G. Axell, 601 City Hall Square Bldg., Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

Pratt Institute, Brooklyn, N. Y., announces that Wednesday evening, March 10, will be observed as "Visitors' Night" in the School of Science and Technology, and the shops, laboratories and drawing rooms will be open to the public. All persons interested in industrial education will be given an opportunity not only of viewing the students at work in the various courses, but also of inspecting both the results and facilities of the institute for industrial training.

NEW BOOKS AND PAMPHLETS

Bulletin of the Bureau of Standards. 187 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C.

Annual Report of the Director Bureau of Standards. 99 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C.

Morris Plan of Industrial Loans and Investments. 68 pages, 6 by 9 inches. Published by the Industrial Finance Corporation, New York City.

Industrial Arts Index, 1914. Edited by Marion E. Potter and Louise D. Teich. 434 pages, 7 by 10½ inches. Published by H. W. Wilson Co., White Plains, N. Y.

Measurement of Time and Tests of Timepieces. 39 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 51.

National Standard Hose Couplings and Fittings for Public Fire Service. 23 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular of the Bureau of Standards No. 50.

Hydration of Portland Cement. By A. A. Klein and A. J. Phillips. 71 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper of the Bureau of Standards No. 43.

Studies on the Silver Voltameter. By G. A. Hulett and G. W. Vinal. 18 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 240.

Analysis of Coal with Phenol as a Solvent. By S. W. Parr and H. F. Hadley. 41 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 76. Price, 25 cents.

Absorption, Reflection and Dispersion Constants of Quartz. By W. W. Coblentz. 11 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 237.

Electrical Resistance and Critical Ranges of Pure Iron. By G. K. Burgess and I. N. Kellberg. 14 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 236.

Direct-reading Instrument for Measuring the Logarithmic Decrement and Wave Length of Electro-magnetic Waves. By Frederick A. Kolster. 34 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 235.

Characteristic Equations of Tungsten Filament Lamps and Their Application in Heterochromatic Photometry. By G. W. Middlekauff and J. F. Skogland. 51 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper of the Bureau of Standards No. 238.

Lubrication of the Motor Car Chassis. Chart published by Norman W. Henley & Son, New York City. Price, 25 cents.

This chart shows a plan view of a typical six-cylinder chassis of standard design. All parts that demand oil are clearly indicated. It is a practical chart for all interested in motor car maintenance.

Mechanical World Pocket Diary and Year Book for 1915. 330 pages, 4 by 6 inches. Illustrated. Published by Emmott & Co., Ltd., Manchester, England; distributed in the United States by Norman, Remington Co., Baltimore, Md. Price, 50 cents.

This well-known compilation of useful engineering rules, tables, formulas and data has been issued consecutively for twenty-eight years. The book treats of steam and steam engines, steam turbines, condensers, gas engines, gas producers, boilers, materials for construction, shafting, gearing, machine shop practice, belting, hydraulics, weights and measures, logarithms, trigonometrical tables, etc. A diary for every day in the year is also included, and a complete index makes reference to the matter contained convenient.

Outlines of Lessons. Bulletin No. 10 of the Wisconsin State Board of Industrial Education, containing proceedings of the Conference and Institute of Teachers held at Milwaukee, Wis., September 2-4. 377 pages, 6 by 9 inches. Published by the Wisconsin State Board of Industrial Education, Madison, Wis.

This bulletin should be of general interest to superintendents of industrial, commercial, continuation and evening schools, as it contains the outlines of lessons in English, hygiene, safety, shop drawing, mechanical drawing, shop mathematics, applied mathematics, shop construction, cooking, bookkeeping, shorthand, business practice, practical art, typewriting, printing, advertising, commercial activities, etc., for apprentices and boys and girls in various grades.

Mechanical World Electrical Pocket Book for 1915. 240 pages, 4 by 6 inches. 129 illustrations. Published by Emmott & Co., Ltd., Manchester, England. Distributed in the United States by Norman, Remington Co., Baltimore, Md. Price, 50 cents.

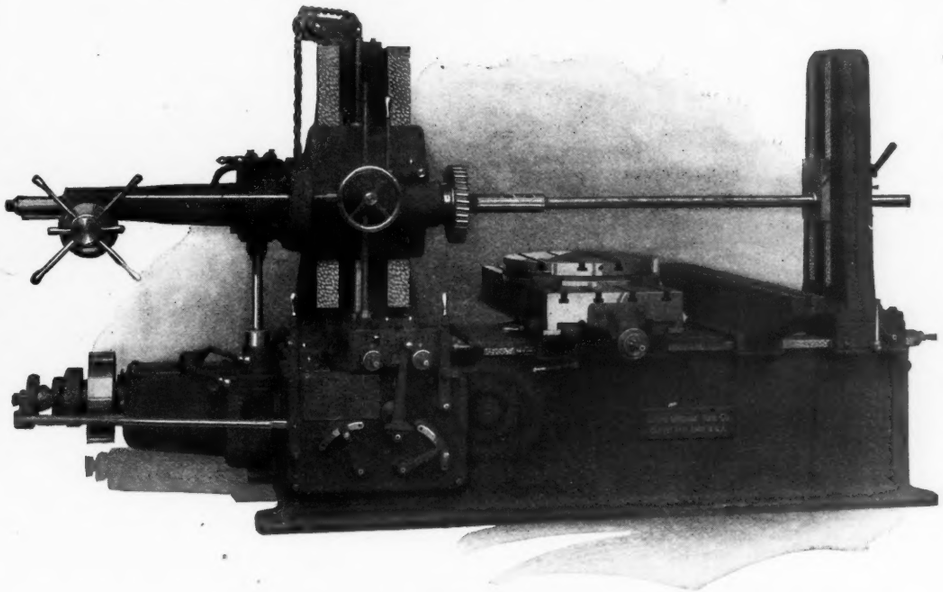
The improvements in the present issue of this handbook pertain largely to the revision and expansion of several of the sections. Many new features have also been introduced; for example, a section on electric circuits and switching is now included, as well as matter on synchronising and phasing-out. The section on electricity on shipboard has been re-written and considerably extended, and the matter treating of electric lamps and electric light has been brought up to date.

Drake's Telephone Handbook. By David Penn Moreton. 286 pages, 4¼ by 6¾ inches. 161 illustrations. Published by Frederick J. Drake & Co., Chicago, Ill. Price, $1.

In this volume the author has endeavored to cover the field in such a way that the book will prove of value to all interested in the various phases of the telephone industry. The material is divided into ten chapters on the following subjects: Electrical Circuits and Electrical Units;

It is Fashionable Just Now to Talk About "SERVICE," But "Actions Speak Louder Than Words"

THE "PRECISION" BORING DRILLING and MILLING MACHINE ACTS



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"The Lucas is the one faithful machine in the shop; no trouble in 9 years of service."

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to drive bushings into holes and straighten things, or even pound a broach through a hole, you need a

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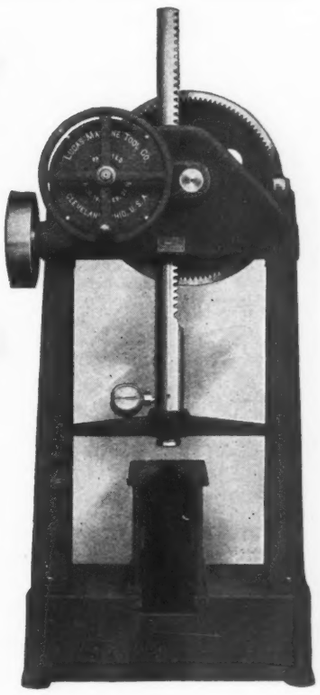


which you are

Paying for Anyhow

(in higher cost of hand work), so why not have *something to show for your money?* It can be furnished with a *ratchet pressure holding attachment* for stacking armature and transformer plates, etc.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

Magnetism, Electromagnetism and Electromagnetic Induction; Batteries; Alternating-current Circuit, Inductance and Capacity; Measurement of Resistance and Capacity, and Location of Faults in Circuits; Sound; Magneto Telephone Instruments and Magneto Systems; Common Battery Systems; Construction of Telephone Lines; Telephone Troubles and How to Find and Remedy Them.

Installing Efficiency Methods. By C. E. Knoeppel. 258 pages, 7 by 10 inches. 98 illustrations, charts and diagrams. Published by the Engineering Magazine, New York City. Price, $3.

In this book which forms the latest addition to the Engineering Magazine's Works Management Library, are described the methods to be employed to increase efficiency of the manufacturing establishment, and how they may be put into practical effect. It analyzes the work of the efficiency engineer and tells how he proceeds to apply these principles in a manufacturing plant. The work is composed largely of matter published in the Engineering Magazine, and its contents by chapter heads are as follows: The Conditions; The Preliminary Investigation; The Conclusions; Results and Objections; The Self-Examination and Decision; The Business Analysis; The Diagnosis; Prescribing the Treatment; The Engineer, The Management and the Men; The Time Study; The Planning Department—Analysis and Material Control; The Planning Department—The Necessary Machinery; The Planning Department—Auxiliary Devices; Standardizing the Working Conditions; Standardizing the Operations; the Bonus Plan or Wage Payment; The Efficiency Clearing House; Manufacturing Costs.

Official Proceedings of the American Railway Tool Foreman's Association. 145 pages, 6 by 9 inches. Illustrated. Published by the Association. A. R. Davis, secretary-treasurer, 750 Pine St., Macon, Ga.

The official proceedings comprise the papers presented at the sixth annual convention held at the Hotel Sherman, Chicago, July 20-22, 1914, as follows: "Standardization of Reamers for Locomotive Repair Shops," by C. A. Shaffer, E. J. McKernan, J. T. Mauger, W. J. Eddy and J. E. Dosser; "Toolroom Grinding," by E. R. Purchas, W. C. Diebert, J. C. Bevelle, Owen D. Kinsey and Thomas F. Eaton; "Safety as Applied to Grinding Wheels," by R. G. Williams; "Machine Tool Repairing," by J. B. Hasty; "Machine Repairs, Methods of Handling, Records, etc.," by George Tothill and G. W. Smith; "Distribution of Tools for Shop Use, Arrangement of Tool Racks, Delivery of Tools," by Henry Otto, W. E. Ross, and J. T. Fuhrman; "Special Tools for Drilling, Reaming and Milling," by J. J. Sheehan, Thomas F. Eaton, H. B. Miller, R. Dolensky, W. L. Stephenson and W. E. Goodwin; "Special Dies for Cold Work—Cold Punching Dies," by B. Henricson and John Ulrich.

The Design of Steam Boilers and Pressure Vessels. By George B. Haven and George W. Swett. 416 pages, 6 by 9 inches. 197 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $2.50.

With the idea of harmonizing the rational methods of theory and practice, the authors of this book have sought to incorporate in its pages the most direct procedure possible in the design of steam boilers and other pressure vessels. The present practice in boiler making has been kept constantly in view, and wherever possible the results have been obtained by rational rather than by empirical methods. The design of many types of boilers is largely the result of experience and well established precedent, and it is therefore hoped that the definite program followed in working out the problems contained in the work will be of value not alone to students, but to all engaged in boiler making and design. The data and constants assumed have been obtained from safe practice and represent wide margins. The book is divided into eight chapters, dealing with general principles, stresses in pressure vessels, fastenings by riveted joints, general proportions, design of a horizontal return tubular boiler, design of a dry back Scotch boiler with combustion chamber in shell extension, design of a vertical straight shell multitubular boiler, design of a locomotive type boiler for contractors' use, and tank design.

NEW CATALOGUES AND CIRCULARS

Harrison Safety Boiler Works, Philadelphia, Pa. Pamphlet No. 17 on the Sorge-Cochrane hot process system of softening boiler feed water.

Cutler-Hammer Co., Milwaukee, Wis. Circular of push-button lamp sockets designed to supersede the thumbscrew type.

Cleveland Worm & Gear Co., Cleveland, Ohio. Leaflet advertising Cleveland accurately cut worm-gearing and worm-gear reduction cases.

Toledo Scale Co., Toledo, Ohio. Catalogue on Toledo springless automatic scales, designed for use in factories, mills, warehouses, foundries, etc.

Allen Mfg. Co., Hartford, Conn. Leaflet on "Allen" safety set-screws of the headless and socket-head types, made in sizes from ¼ to 1½ inch diameter.

Gas Engine & Power Co., and Charles L. Seabury & Co., Morris Heights, New York City. Catalogue 11 descriptive of Seabury marine steam engines for commercial and pleasure craft.

American Blower Co., Detroit, Mich. Bulletin showing the installation of the "Sirocco" heating and ventilating system in the Fletcher Savings & Trust Co. Bldg., Indianapolis, Ind.

Ajax Mfg. Co., Cleveland, Ohio. Circular showing how it is possible to gather profits from the scrap pile by the use of Ajax reclaiming rolls that roll round, square or flat bars from low-priced scrap.

Dillon Electric Co., Canton, Ohio. Circular on the Dillon electric grinder, made for 110 and 220 volts direct current, and 110, 220, 440 and 550 volts, 60 cycles, alternating current, one-, two- and three-phase.

Stow Mfg. Co., Binghamton, N. Y. Bulletin 54, illustrating Stow suspended type direct-connected drill, buffer or grinder, Stow general utility tool for die-sinking, drilling, buffing, grinding, etc., and Stow two-spindle drill.

American Pulley Co., Philadelphia, Pa. Circular advertising "American" pulleys. The stock sizes of these pulleys are from 3 to 72 inches diameter inclusive. All pulleys above 6 inches in diameter have grooved faces.

National X-Ray Reflector Co., 235 W. Jackson Blvd., Chicago, Ill. "Eye Comfort," a monthly publication treating of proper methods of illumination, and describing the "Eye Comfort" indirect lighting fixtures marketed by this firm.

Gas Engine & Power Co. and Charles L. Seabury & Co., Morris Heights, New York City. Catalogue on the "Seabury" water tube boiler for stationary and marine service. Details of construction and instructions for the operation and care of "Seabury" water tube boilers are given.

Adjustable Ratchet Wrench Co., Room A 1651 Marquette Bldg., Chicago, Ill. Circular giving price list of the "Anderson" adjustable ratchet wrench. This wrench is adjustable to any kind or size of nut or bolt, and it works at every angle. It is made in 6-, 8- and 10-inch sizes.

Boston Gear Works, Norfolk Downs, Mass. New 1915 catalogue E8, listing the complete line of gears made by this company. The company makes a specialty of all kinds of steel gears including automobile differential and transmission gears as well as fan, cam, timer and pump gears for engines.

George W. Southwick Co., Stamford, Conn. Circular of twisted round belt lacing manufactured in the American plant of William Burke Sons Co., England, working under the management of George W. Southwick Co. This lacing is noted for its ductility, absence of stretch and great tensile strength.

Buffalo Forge Co., Buffalo, N. Y. Bulletin 182 E treating of the various types of Buffalo blowers and exhaust fans built for direct connection to motors. The line shown ranges from the large ventilating and drying fans down to the "Baby Conoidals" for ventilation of moving picture booths, drying cabinets, etc.

Doane Mfg. Co., Boston, Mass. Leaflet on the "Doctor" ferrules and file handles, which are designed to meet the increasing demand for a non-splitting file handle. The ferrule is made of heavy pressed steel, enlarged at the head, and it firmly locks the wooden portion within the enlarged end, when driven into place.

Willmarth Tool Works, 1516 E. 32d St., Cleveland, Ohio. Circular descriptive of the Willmarth two-foot radial drill. This machine is designed to withstand the strains to which modern machine tools are subjected by high-speed steels. It has the rigidity of an upright drill combined with the flexibility of the radial type.

Felt & Tarrant Mfg. Co., Chicago, Ill. Pamphlet on the comptometer as applied to engineering calculations incident to the work of civil, mechanical, electrical, hydraulic and mining engineers, architects, builders, contractors, etc. Some examples of calculations that can be advantageously performed in the engineer's office are included.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 200 on Buffalo "Planoidal" (type L) fans, which are a modification and improvement on the older type of steel plate heating and ventilating fans with a comparatively small number of radial blades. It is expected that under most conditions this type of fan will compete on an equal basis with multi-blade fans.

Fafnir Bearing Co., New Britain, Conn. Catalogue 15 on ball bearings, giving tables of dimensions of Fafnir radial ball bearings, two-row radial ball bearings, self-aligning radial ball bearings, self-aligning two-row radial ball bearings, cone type ball bearings, magneto type ball bearings, ball thrust bearings, ball thrust bearings—self-aligning type.

D. & W. Fuse Co., Providence, R. I. Catalogue on magnetic chucks, showing flat and rotary chucks, and attachments for converting flat chucks into the vertical, taper or swiveling types. A number of illustrations also show these chucks applied to a planer and internal, surface and disk grinders. Price lists of magnetic chucks and direct-current generators for operating them are included.

General Electric Co., Schenectady, N. Y., announces that it has standardized the concentrated filament "Mazda" lamps in the 25, 40 and 60 watt sizes which are designed to give greater downward distribution of useful light than is possible with the regular "Mazda" lamp of corresponding wattages. These lamps will be made in the same size bulbs as the regular standard "Mazda" lamps, and will have a rated average life of 600 hours.

H. D. Smith & Co., Plantsville, Conn. Circular advertising the "Perfect Handle" screwdriver. This screwdriver is drop-forged from a solid piece of steel, and has a wooden handle. The steel is closed in over the wood at each end, protecting it thoroughly. The "Perfect Handle" screwdriver can be supplied with three bits. When equipped in this way, screws can be operated in places that are not accessible by the ordinary screwdriver.

Harrison Safety Boiler Works, Philadelphia, Pa. Catalogue on "Cochrane" multiport valves, describing multiport valves intended for back pressure relief and vacuum service, flow service in connection with mixed flow turbines and check valve service with bleeder or extraction turbines. In addition to the descriptive and tabular matter, the book contains numerous diagrams and layouts as well as data on the effects of air in condensers and on turbine performance.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 201 dealing with "Niagara Conoidal" fans. These fans, besides having all the advantages of the multi-blade type in respect to high operating speeds, compact arrangement and rigidity, are equipped with blades which are so shaped and proportioned to the housing that it is possible to convert into static pressure the velocity head, which is much higher in proportion to the total pressure with multi-blade fans than with the older types having few blades.

Ajax Mfg. Co., Cleveland, Ohio. Circular devoted to Ajax taper forging rolls, which are adapted for the rapid and economical production of forged taper pieces. These machines are very rigidly constructed and all gears are enclosed in guards. Some of the forgings that can be produced on these taper forging rolls are pictured as a suggestion of the possibilities of the machines; these are brake levers, brake shoe keys, trolley poles, drag bars for agricultural implements, seat springs, wedges, ship liners, tapered tubes, tongs, etc.

Ajax Mfg. Co., Cleveland, Ohio. Catalogue and reference book on Ajax hot metal-working machines. Among the products of this company are: rivet and bolt headers, axle upsetting machines, bolt heading, upsetting and forging machines, standard and high-speed bulldozers, hot sawing and burring machines, universal forging machines, hot pressed nut machines, taper forging rolls, and reclaiming rolls. The book illustrates the machines, as well as the product produced by them, and explains the points of merit incorporated in the various designs, with the aid of detail views. The descriptive matter is clear and well arranged.

Charles H. Besly & Co., 120B N. Clinton St., Chicago, Ill. Catalogue on Besly patternmakers' grinders, showing illustrations of these grinders in operation in a number of different plants. Some of the important parts, such as adjustable work-table, sliding bevel gage, sizing circle gage, angle-plate, roll-sanding attachment, etc., are shown in detail. These grinders are made in three types, with disk wheels 30 and 40 inches in diameter as follows: Type A, with disk wheel and work-table on one end only; Type B with disk wheel and work-table on both ends; and Type C with disk wheel and work-table on one end and roll sanding attachment on the other end.

Chain Belt Co., Milwaukee, Wis. General catalogue 56, dealing with elevating and conveying machinery, chain belt, sprocket wheels, transmission machinery, etc., for saw mills, cement mills, canning plants, power plants, sand and gravel plants and practically every line of industry. The two chain belts particularly featured are the "Griplock" and the "Chabelco" chain belts which are designed for especially heavy work. The former is made from malleable iron and the latter entirely of steel. The catalogue gives complete information on the company's product and includes tables of useful data, such as horsepower transmitted by cut gearing, weights of materials, weights of steel angles, weight per foot of round and square steel bars, areas and circumferences of circles, etc.

De Laval Steam Turbine Co., Trenton, N. J. Catalogue of De Laval centrifugal pumps, containing 298 pages and over 300 illustrations. It is a catalogue of centrifugal pumps for all capacities and heads, motor and steam turbine driven. Diagrams showing the characteristics of such pumps and explaining the relation between the impeller blades, angles and characteristics are included. The text matter is divided into chapters under headings as follows: The Introduction of the Centrifugal Pump and the Work for which it is Adapted; Features to be Considered in Selecting Centrifugal Pumping Equipment; The Use of the Characteristic Curve; Method of Testing Centrifugal Pumps; System of Manufacture for the Production of Interchangeable Parts; Details of Design and Construction of Single-stage and Multi-stage Pumps; The Speed Question, Particularly Relating to Steam-Turbine-Driven Centrifugal Pumps; Helical Speed Reducing Gears; Motor and Belt Drives; High Duty Steam-Turbine-Driven Pumps as Compared with Reciprocating Pumping Engines for Water Works Service; The Adaptation of Pumps for Circulating Condenser Water, Feeding Boilers and Other Steam Power Plant Service; Drainage and Irrigation Pumps; Hydraulic Pressure and Elevator Pumps; Pumps for Marine Uses, Mining Service, Power Service and Hot Water and Brine Circulation. Valuable tables and charts are also included.

TRADE NOTES

Ingle Corporation, Rochester, N. Y., maker of gear tooth grinders and special machinery, has changed its name to the Merchants Machine Co.

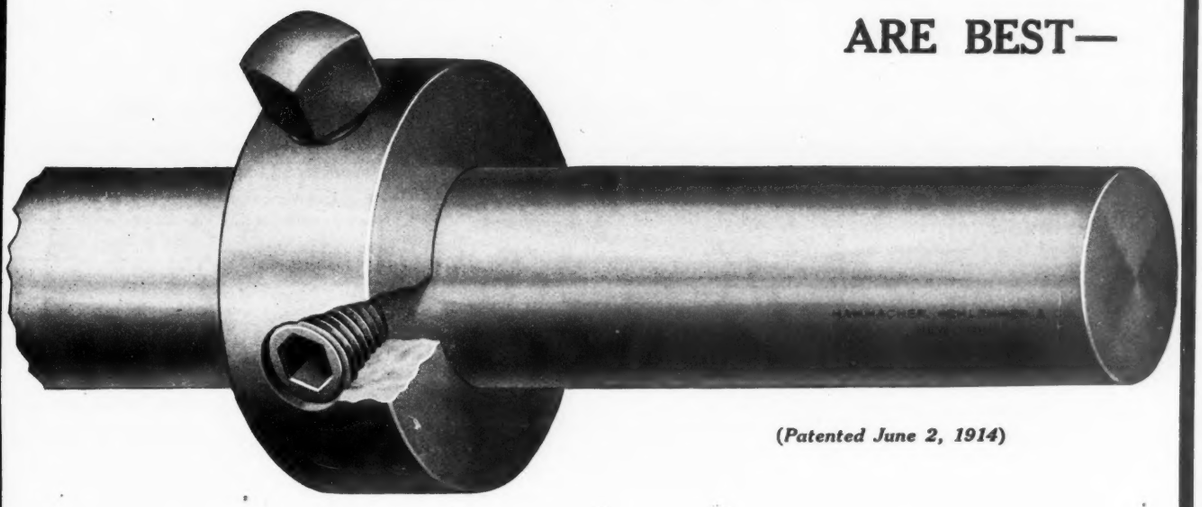
Standard Welding Co., Cleveland, Ohio, has added seventy-nine men to the working force of its automobile rim department. The added working force will bring the production of rims above normal.

Electric Controller & Mfg. Co., Cleveland, Ohio, announces that the O. H. Davidson Equipment Co.,

WHY THE IMPROVED H. S. & CO.

HOLLOW OR LIFE SAVING SET SCREWS

ARE BEST—



(Patented June 2, 1914)

BECAUSE they are perfectly casehardened.

BECAUSE the hexagonal hole is very slightly wider at the top to permit easier "finding" of the hole by the wrench.

BECAUSE H. S. & Co. Screws have a slight bevel at the opening which aids in inserting the wrench.

BECAUSE the hexagonal formation is perfect and conforms properly with the wrench, to insure proper tightening of screw.

BECAUSE of this the wrench sets at the bottom of the hole, thus insuring proper bearing of the wrench to give greatest strength where it is most needed.

Ask for Descriptive Circular No. 3334 and Samples

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

4th Avenue and 13th Street NEW YORK, SINCE 1848

Ideal Bldg., Denver, Colo., will act as its representative in Colorado, Utah, Montana, Wyoming, South Dakota, New Mexico and Arizona.

Standard Welding Co., Cleveland, Ohio, has recently received an order from the Willys-Overland Co. for nearly half a million demountable rims to be used on motor cars. To produce this quantity, more than five thousand tons of steel will be used.

Walter McNeil, New Glasgow, N. S., has recently purchased the plant formerly owned by the Fraser Machine & Motor Co., Ltd., of New Glasgow, and is extending the business and installing a large number of new tools. He is desirous of receiving catalogues dealing with machinery and tools and covering all phases of the iron and metal trade.

American Pulley Co., Philadelphia, Pa., manufacturer of "American" wrought steel split pulleys, will open its own store at 119 Jackson St., Seattle, Wash., where a large stock of pulleys for the accommodation of dealers in the Northwest will be carried. Archie Chandler of Seattle will represent the company in the distribution of its product among dealers on the Pacific coast.

Hendey Machine Co., Torrington, Conn., was made defendant in a suit brought by the Neil Machinery Co., 50 Church St., New York City, for commissions on sixty-eight milling machines furnished to the Remington Arms Co. Inasmuch as the Hendey Machine Co. felt that the Neil Machinery Co. had no just claim for the commissions demanded it allowed the case to go to court, and a decision was rendered in its favor in February.

Carborundum Co., Niagara Falls, N. Y., is showing an extensive exhibit in the Machinery building at the Panama Exposition which opened February 20. The exhibit covers a wide range and is intended to show the public some of the many purposes to which modern artificial abrasives are applied. It will include over four hundred different exhibits, ranging from steel shafts to watch dials, from tooth-picks to sections of flooring, flour mill rolls to needles, etc. The exhibit occupies 1400 square feet.

Hoover Steel Ball Co., Ann Arbor, Mich, manufacturer of bearing balls, will erect a one-story concrete and brick building 40 by 253 feet to afford better facilities for its rapidly growing business. The new building will house the inspection and finishing departments and fireproof storage vaults for finished balls. The buildings in which these departments are now located will be devoted to the preliminary stages of ball making. The additional special machinery for grinding high-grade micro-chrome balls is being built in the company's tool shop.

Olmsted-Flint Co., manufacturer of leather belting, has removed its general headquarters from Lawrence to Cambridge, Mass. The new plant is located at the corner of Main and Portland Sts., and is a two-story brick factory building that has been completely remodeled. On January 1 Frank M. Schiffmacher, who has previously been in charge of the manufacturing end of the business, purchased complete control and is now president and treasurer of the company. In connection with the installation of its plant at Cambridge, the company will extend its business to include a complete line of pulleys, shafting, hangers and other transmission appliances.

Classified Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

HELP WANTED

PRACTICAL MAN with executive ability to systematize Gear Manufacturing Plant. Permanent employment if satisfactory. Box 706, care MACHINERY, 140 Lafayette St., New York.

WANTED AGENTS.—Saunders' Pocket "Hand Book of Practical Mechanics" for tool chest $1.00 only. Why pay more? It fills bill for shop kinks, ready reference, simple arithmetic. Send for circular. E. H. SAUNDERS, 16 Purchase St., Boston, Mass.

FACTORY ENGINEERS.—Several Technical graduates who have had the following experience: Methods of handling materials, improvements, changing of machinery, etc. Write giving age, experience, references and salary wanted to Box 707, care MACHINERY, 140 Lafayette Street, New York.

SIDE LINE SALESMEN.—Turn that spare time into dollars. We have a patented article that sells to every factory in the United States. Something new and good. Pocket sample. Large commissions. If you call on the mechanical trade it will pay you to investigate. AMERICAN SPECIALTY CO., Dept. M., 1812 Heyworth Bldg., Chicago, Ill.

WANTED.—COMPETENT MACHINERY SALESMAN to handle side line, good proposition, good commission, MELLON MCH. CO., Kansas City, Mo.

FOR SALE

HILL'S TEST INDICATOR on approval. Circular. M. B. HILL MFG. CO., Worcester, Mass.

GET A "LAST-WORD."—The Test Indicator Par Excellence. H. A. LOWE, 1374 E. 88th St., Cleveland, O.

ATTENTION! MACHINISTS.—$1.00 buys Saunders' Pocket "Hand Book of Practical Mechanics." Increase your salary. It gets there. Send for circular. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

COMBINED THREAD AND CUTTING-OFF TOOL. Sent on approval. Circular. M. B. HILL MFG. CO., Worcester, Mass.

FOR SALE.—A large interest in well-established machine shop in Hartford, Conn. Incorporated and a going concern. Fine opening for a man with some capital and manufacturing experience. Box 715, care MACHINERY, 140 Lafayette St., New York.

FULL SETS OF DRAWINGS, patterns and jigs for 14", 16", 18" and 20" lathes, both cone head and geared head; also a lot of miscellaneous finished parts for above. Box 711, care MACHINERY, 140 Lafayette St., New York.

FOR SALE.—Gridley Piston and Piston Ring machines; also No. 52 and 53 National-Acme automatic screw machines, extra tooling thrown in. Excellent condition. Will sacrifice for quick sale. Machines may be seen at our Providence, R. I., factory. Prices and further information from AMERICAN LOCOMOTIVE COMPANY, Automobile Department, 30 Church Street, New York.

MACHINISTS, TOOLMAKERS.—The best small handbook for the shop. Technical and economic information. The things you need made plain. Vest pocket size. Flexible covers. Price 25 cents. WM. CUTHBERTSON, 39 Springside Avenue, Pittsfield, Mass.

EMPLOYMENT AGENCIES

IF YOU ARE REALLY a $2,500 to $12,000 man and would consider overtures from desirable firms, signify same by sending your address only (for particulars) to undersigned counsel who will negotiate preliminary correspondence without revealing your name or connection. Strictest professional privacy. R. W. BIXBY, Lock Box 134-J3, Buffalo, N. Y.

SITUATIONS WANTED

SUPERINTENDENT of first-class firm manufacturing automobile motors desires change. Good organizer, producing at amazingly low cost. Will arrange to show through shop where now employed. Best references. Box 704, care MACHINERY, 140 Lafayette St., New York.

YOUNG MAN; technical graduate; four years machine shop practice; four years machine designing and mechanical engineering. Box 714, care MACHINERY, 140 Lafayette St., New York.

SITUATION WANTED.—By mechanical draftsman, who has also had shop experience. Address ROBERT SAULSBURY, 200 W. Main St., Batavia, N. Y.

WANTED.—Position, preferably in drafting-room, by young man, age 22, four years' experience as machinist and toolmaker. Nearly completed I. C. S. course in Mechanical Engineering. Box 709, care MACHINERY, 140 Lafayette St., New York.

MANUFACTURERS' AGENT. — Boston headquarters—covering New England, wants to enlarge operations. An exclusive line is desired, selling to manufacturers and mills. We are established and are getting results. Box 712, care MACHINERY, 140 Lafayette St., New York.

YOUNG MECHANICAL ENGINEER, single, at present employed in Philadelphia, desires charge of office of manufacturing concern. Technical graduate, 5 years' experience designing, drafting, estimating, cost-keeping, correspondence. Familiar with shop practice and commercial methods. Box 716, care MACHINERY, 140 Lafayette St., New York.

FOREMAN OR ASSISTANT FOREMAN by man now in charge of department in machine tool plant. Twenty-two years' shop experience; thorough knowledge of modern tools; can speak German and English, understands mechanical drawing, and can handle men successfully. Box 717, care MACHINERY, 140 Lafayette St., New York.

DRAFTSMAN, designer, machinist, with technical training and experience in handling men—electricians, machinists, carpenters, pipefitters, engineers, etc. Now employed, but desires to be connected with firm having opportunities of advancement and where enthusiasm is appreciated. Box 708, care MACHINERY, 140 Lafayette St., New York.

MECHANICAL ENGINEER.—College graduate; age 23; energetic and a hustler, desires change. East preferred. Experienced in machine design and construction; efficiency and experimental work. At present with large concern in Middle West. Salary not important part if ability entertains advancement. Best of references on request. Box 713, care MACHINERY, 140 Lafayette St., New York.

CONTRACT WORK

HARDENING, Carbonizing, Galvanizing. C. U. SCOTT, Head of Wall St., Davenport, Iowa.

AUTOMATIC AND SPECIAL MACHINES designed. Working drawings. Tracings. Special Tools and Fixtures designed. C. W. PITMAN, 3519 Frankford Ave., Philadelphia, Pa.

WE ARE EXCEPTIONALLY WELL FITTED to build your light and medium weight machines on contract in reasonable lots. Can store finished material, shipping direct to consumer your single orders or in lots and take the factory end entirely off your hands. Best of shipping facilities. Prompt and efficient service. High-class workmanship. Prices right. HOYSRADT & CASE, Kingston, N. Y.

PATENTS

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

PATENTS SECURED.—C. L. PARKER, Ex-member Examining Corps, U. S. Patent Office. Instructions upon request. 900 G St., N. W., Washington, D. C.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information.

PATENTS.—A book on patents and patent law for the practical man. Contains the principal provisions of the patent law, describes in detail the procedure in obtaining a patent, and deals with patent infringements. Not a book for patent lawyers, but for practical mechanics. Price, 25 cents. MACHINERY, 140 Lafayette St., New York.

MISCELLANEOUS

LIVE SHOP AGENTS WANTED to distribute our tools. WELLES CALIPER CO., Milwaukee, Wis.

AGENTS IN EVERY SHOP WANTED to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Tampa, Fla.

AMERICAN COMPANIES SEEKING EUROPEAN REPRESENTATION should communicate at once with the undersigned (officer in the French Army) who has heretofore had large experience and acquaintance in both the Railway and Metal trades. United States references can be given. J. M. A. GASSMANN, 9, Rue Baudin, Paris, France.

WANTED.—A SMALL TURRET LATHE, 12" or 14" swing, hexagon head; must be in first-class condition; state full particulars. WEST SIDE FOUNDRY CO., Troy, N. Y.

REPRESENTATION WANTED.—A reputable old established firm in Paris, France, is seeking to represent a first-class American manufacturing concern of the machinery branch and hardware trade, suitable for the European market. Possesses really capable and well-organized, experienced selling staff. Only a first-class house wishing to give a sole agency considered. Highest credentials and banking references furnished. Reply in first instance with full particulars to JAMES BEMANT, 63 bis, Rue de la Victoire, Paris, France.

MACHINERY WANTED.—Double disc grinders either Gardner or Besly. Also vertical surface grinders, and 12" to 14" heavy spindle lathes, 5 to 6 foot bed. Must be in good order and price low. Send particulars to THOMAS BROWN, Superintendent, 374 Jelliff Ave., Newark, N. J.

TO RENT.—LARGE MACHINERY HOUSE in lower part New York City will rent part of store, show window and shipping facilities to manufacturer of machine tools, steam pumps, gas engines or contractors' machinery. A fine chance for party wishing New York representation. Price low. J. W., Box 710, care MACHINERY, 140 Lafayette St., New York.

AGENCIES DESIRED IN PARIS.—Mechanical engineer, 35 years of age, good representative, accustomed to handling big business, formerly general agent for the foremost machine tool manufacturers in Europe, business disorganized because of the war, desires general agencies or commercial direction in France for large machine tool manufacturers or dealers. If necessary, can furnish an organized office, fully equipped. First-class references furnished. Address ROSEN-FRANC, 35 Boulevard-Capucines, Paris.